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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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## Retrospective, 1927.

The year which is just passing may go down in history as the "get-together" year. Though there is not much of material evidence to support this, there has undoubtedly been a more tolerant attitude in every phase of activity, especially political and industrial. The Foundry industry of the world has achieved its "get together" in a practical manner, by forming an International Technical Committee. It is reasonably complete now that the Americans are active participants. The foundry world owe a debt of considerable magnitude to Mr. Paul Ropsy for his energy and foresight in launching the scheme, and we are sure that the high ideals which have so far animated the deliberations of the committee, will be continued under the guidance of Dr. Werner, its ruling President.

The Institute of British Foundrymen continues to render signal service to the industry for which it caters. The membership is growing, not rapidly, but steadily; trade conditions do not allow of massed enrolment at some firm's expense—a phase of membership which is neither reliable nor desirable. Last summer a very successful conference was held at Sheffield. It was a model organisation, and Mr. MacDonald and Mr. Makemson (the newly-appointed Secretary) thoroughly deserved the praises bestowed upon them. At this meeting, Mr. J. T. Goodwin was elected President, and once again, after an interval of some twenty years, what the French call "Grande Metallurgie" is represented in the chairmanship. Its last representative was the late Mr. Pilkington. Later on in the year a large number of the members took part in an important foundry congress, held in Paris in September. Running concurrently was a foundry exhibition in the wider sense of the word. We came away with the impression that the foundry exhibits were definitely cleverer and more impressive than those of their supplies of machinery and requisites.

The number of Papers to be given this year before its members undoubtedly creates a record. The newer Branches and Sections, such as Middlesbrough, Paisley, Burnley, Wales and the West Riding, are making commendable progress, whilst of the older ones, the London Section should certainly be singled out for praise on account of its growth in membership and influence.

The British Cast Iron Research Association is following a definite policy which emphasises the value of a certain amount of centralisation. They now have their offices and laboratories all under one roof, and hope, in the future, to procure an experimental foundry in a near-by manufacturing establishment. The policy followed by some research organisations of carrying out its work at some university has one great disadvantage, that of inefficiency due to human nature, and isolation. The reference to "human nature" is meant to cover the case of a comparatively young man, working in close association with irresponsible students, and away from the personal control of his chief. We hope to see the present nucleus of research workers in cast iron closely co-operating amongst themselves for the benefit of the industry, the future prosperity of which lies largely in their ability to provide it with fundamental data and pointers for industrial applications.

The Foundry Equipment and Supplies Association has already commenced its arduous task of staging, in 1929, an exhibition of an international character, and of a magnitude and interest comparable with Detroit, Dusseldorf and Paris.

Visualising the foundry industry as a whole, trade conditions have been better than for the last two years; last year, of course, scarcely counts owing to the coal dispute. Its largest output, that of cast-iron pipes, has made good progress, at least in the export market. We should, however, like to see a larger British participation in the supply of the American eastern seaboard import market, where the French makers apparently have such a happy hunting ground. The home market has not been quite so healthy, due in some measure to a slight falling off in the construction of new houses, especially along the new arterial roads.

The light-castings industry has lost some ground in exports and the bath section in particular, mainly amongst those who manufacture them amongst other classes of goods. The industry, too, is suffering from the falling off in building construction.

The electrical foundries, however, have been exceptionally busy, one of them having had no less than 41 other foundries augmenting their own resources.

The automobile foundries, which are the pride of the British foundry industry, were kept reasonably busy, with the exception of some newcomers to the trade, who have not yet got the confidence of the buyers.

Marine foundries, though still far from busy, have experienced better trading conditions than for several years. The black spot in the industry is the textile machinery section, but even there some foundries catering for the artificial silk business have been really busy. The railway foundries, too, have had a fairly thin time, whilst those catering for the mining industry have been starved of orders. The printing machinery and jobbing foundries have been kept reasonably well employed, whilst the agricultural shops have "turned the corner" after experiencing years of depressed conditions.

The steel founders in general have had better trading conditions, French and Belgian competition has been less severe, but there is a recrudescence of German activity, a factor which will have to be counted upon in the future. The failure of one large steel foundry was not due to trading conditions, but rather to a legacy of previous lean and perhaps fat years. The non-ferrous industry has been generally active, and they, too, are a clear reflection of general trade conditions; unitarily, of course, they have been affected by the industry for which they cater, and which we have covered in our remarks on the iron foundry industry.

The malleable cast-iron trade has made solid progress, especially the larger foundries, which have instituted rigid metallurgical control. It is pleasing to record that this year has seen the establishment of an important new malleable foundry, and its progress will be watched with interest by the industry. Prospects for 1928 will be dealt with next week.

# The Influence of the Cooling Rate on the Maurer Diagram for Cast Iron.

The Maurer diagram demonstrates the relationship between the structure of cast iron and the silicon and total-carbon contents at an ordinary cooling rate. Obviously this relationship will be changed when the cooling rate is not a normal one. The experiments recently made by E. Maurer and P. Holtzhausen* should show how the lines of the diagram are modified by adopting various cooling rates. This was obtained by pouring the iron into moulds of various temperatures, viz., chill mould, sand mould of room temperature, sand moulds preheated to 250 deg. C. and 450 deg. C. respectively. The wall thickness of the chill mould was 1.77 in. The cast bars had a diameter of 1.18 in. and a length of 28.3 in. Irons of various silicon and carbon contents were melted in a coke-fired crucible furnace, the melting temperature being kept as far as possible at the same degree above the various melting points. The moulds after being poured were allowed to stand for at least fourteen hours.

Table I.

| Melt No. | Pouring temp. | Total carbon. | Graphite. Normally cooled. | Graphite. Mould preheated to 250 deg. C. | Graphite. Mould preheated to 450 deg. C. | Si. | Mn. | P. | S. | Brinell hardness. Normally cooled. | Brinell hardness. Mould preheated to 250 deg. C. | Brinell hardness. Mould preheated to 450 deg. C. | Chill cast. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Deg. C. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | t/sq. in. | | | |
| 6 | 1,240 | 3.12 | 2.31 | 2.28 | — | 1.66 | 1.00 | 0.40 | 0.09 | 141 | 138 | — | — |
| 8 | 1,245 | 3.24 | 2.30 | 2.38 | — | 1.39 | 0.95 | 0.41 | 0.09 | 149 | 136 | — | — |
| 9 | 1,250 | 3.20 | 2.28 | 2.39 | — | 1.17 | 1.00 | 0.39 | 0.09 | 151 | 137 | — | — |
| 12 | 1,245 | 3.34 | 0.78 | 1.48 | 2.39 | 0.68 | 1.21 | 0.42 | 0.09 | 246 | 194 | 126 | — |
| 13 | 1,250 | 3.24 | 0.33 | 0.91 | 2.35 | 0.78 | 1.04 | 0.43 | 0.11 | 267 | 214 | 135 | — |
| 14 | 1,200 | 3.35 | 2.27 | 2.32 | 2.44 | 1.11 | 1.07 | 0.41 | 0.05 | 140 | 132 | 121 | — |
| 15 | 1,240 | 3.45 | 0.62 | 1.06 | 2.27 | 0.77 | 1.20 | 0.34 | 0.08 | 203 | 178 | 140 | — |
| 16 | 1,250 | 3.35 | 1.46 | 2.35 | 2.46 | 0.82 | 1.10 | 0.42 | 0.10 | 187 | 159 | 122 | — |
| 17 | 1,245 | 3.22 | 0.91 | 1.53 | 2.33 | 0.84 | 0.89 | 0.40 | 0.11 | 225 | 192 | 127 | — |
| 18 | 1,255 | 3.08 | 0.88 | 1.07 | 1.91 | 0.87 | 0.90 | 0.41 | 0.09 | 250 | 214 | 129 | — |
| 19 | 1,240 | 3.30 | 1.54 | 1.59 | 2.41 | 0.82 | 0.95 | 0.35 | 0.10 | 210 | 171 | 123 | — |
| 21 | 1,260 | 3.11 | 1.51 | 1.91 | 2.16 | 1.00 | 0.91 | 0.35 | 0.12 | 181 | 145 | 135 | — |
| 22 | 1,260 | 3.08 | 1.27 | 1.40 | 2.22 | 0.93 | 1.02 | 0.37 | 0.13 | 267 | 214 | 139 | — |
| 24 | 1,245 | 3.13 | 2.29 | 2.31 | 2.34 | 1.20 | 1.08 | 0.41 | 0.11 | 151 | 133 | 131 | — |
| 25 | 1,235 | 3.20 | 2.29 | 2.32 | 2.35 | 1.40 | 1.12 | 0.41 | 0.11 | 143 | 137 | 126 | — |
| 26 | 1,270 | 2.70 | 1.79 | 1.77 | 1.81 | 1.36 | 0.77 | 0.50 | 0.09 | 161 | 142 | 142 | — |
| 27 | 1,225 | 3.14 | 2.33 | 2.28 | 2.35 | 1.47 | 1.00 | 0.42 | 0.08 | 149 | 136 | 121 | — |
| 28 | 1,255 | 3.14 | 2.31 | 2.37 | 2.44 | 1.63 | 1.12 | 0.42 | 0.11 | 145 | 135 | 126 | — |
| 29 | 1,245 | 3.08 | 2.29 | 2.32 | 2.35 | 1.54 | 0.88 | 0.41 | 0.08 | 144 | 130 | 121 | — |
| 30 | 1,245 | 3.04 | 2.32 | 2.38 | 2.41 | 2.04 | 0.98 | 0.44 | 0.11 | 143 | 132 | 119 | — |
| 31 | 1,270 | 2.82 | 0.15 | 0.23 | 1.42 | 0.98 | 1.18 | 0.42 | 0.08 | 270 | 263 | 164 | — |
| 32 | 1,235 | 2.98 | 2.18 | 2.20 | 2.27 | 1.93 | 0.97 | 0.43 | 0.10 | 140 | 133 | 117 | — |
| 36 | 1,250 | 3.06 | 2.33 | 2.33 | 2.42 | 1.82 | 0.98 | 0.42 | 0.12 | 145 | 133 | 118 | — |
| 39 | 1,250 | 3.42 | 2.24 | 2.54 | 2.56 | 0.82 | 0.74 | 0.42 | 0.11 | 144 | 126 | 119 | — |
| 40 | 1,240 | 3.52 | 2.19 | 2.54 | 2.66 | 0.84 | 0.74 | 0.43 | 0.09 | 152 | 125 | 112 | — |
| 42 | 1,240 | 3.26 | 2.48 | 2.49 | 2.50 | 1.57 | 0.85 | 0.44 | 0.08 | 135 | 124 | 113 | — |
| 43 | 1,235 | 3.54 | 2.06 | 2.24 | 2.61 | 0.70 | 0.92 | 0.41 | 0.06 | 161 | 134 | 110 | — |
| 45 | 1,260 | 3.57 | 1.78 | 2.32 | 2.63 | 0.76 | 1.04 | 0.42 | 0.08 | 161 | 128 | 112 | — |
| 46 | 1,250 | 3.55 | 2.58 | 2.65 | 2.73 | 0.95 | 1.27 | 0.39 | 0.07 | 133 | 118 | 109 | — |
| 49 | 1,250 | 3.38 | 0.66 | 1.94 | 2.38 | 0.74 | 1.00 | 0.36 | 0.08 | 213 | 160 | 138 | — |
| 53 | 1,250 | 3.36 | 2.35 | 2.49 | 2.51 | 1.00 | 0.92 | 0.37 | 0.09 | 138 | 126 | 123 | 335 |
| 54 | 1,250 | 3.37 | 2.54 | 2.51 | 2.56 | 1.37 | 1.07 | 0.34 | 0.08 | 137 | 130 | 120 | 301 |
| 55 | 1,250 | 2.88 | 2.06 | 2.06 | 2.12 | 1.37 | 0.76 | 0.05 | 0.07 | 150 | 135 | 126 | 286 |
| 56 | 1,255 | 3.54 | 2.26 | 2.74 | 2.78 | 0.81 | 1.03 | 0.28 | 0.07 | 149 | 119 | 110 | 322 |
| 57 | 1,255 | 3.64 | 0.04 | 0.06 | 0.96 | 0.48 | 1.00 | 0.06 | 0.05 | 266 | 252 | 132 | 322 |
| 59 | 1,270 | 2.70 | 1.90 | 1.86 | 1.89 | 1.63 | 0.91 | 0.21 | 0.10 | 158 | 146 | 135 | 286 |
| 60 | 1,250 | 2.78 | 2.05 | 2.06 | 2.02 | 1.81 | 0.72 | 0.18 | 0.08 | 147 | 132 | 126 | 299 |
| 61 | 1,250 | 3.50 | 0.02 | 0.01 | 0.01 | 0.28 | 0.71 | 0.18 | 0.06 | 265 | 260 | 257 | 321 |
| 62 | 1,260 | 3.50 | 2.60 | 2.58 | 2.61 | 1.28 | 1.07 | 0.19 | 0.08 | 124 | 111 | 104 | 303 |
| 63 | 1,250 | 3.43 | 2.52 | 2.57 | 2.56 | 1.65 | 1.03 | 0.20 | 0.07 | 128 | 115 | 110 | 255 |
| 64 | 1,265 | 2.90 | 1.05 | 1.95 | 1.92 | 1.18 | 0.83 | 0.06 | 0.08 | 204 | 159 | 130 | 303 |
| 65 | 1,245 | 2.69 | 1.58 | 1.75 | 1.76 | 1.24 | 0.69 | 0.20 | 0.13 | 194 | 175 | 135 | 280 |
| 66 | 1,240 | 3.67 | 2.58 | 2.56 | 2.60 | 0.79 | 0.94 | 0.19 | 0.06 | 145 | 105 | 103 | 332 |
| 70 | 1,265 | 3.50 | 0.82 | 2.06 | 2.54 | 0.65 | 0.68 | 0.04 | 0.09 | 195 | 128 | 103 | 298 |
| 73 | 1,245 | 3.12 | 2.17 | 2.20 | 2.18 | 3.48 | 0.70 | 0.13 | 0.08 | 133 | 123 | 119 | 154 |
| 74 | 1,235 | 3.75 | 2.68 | 2.70 | 2.67 | 0.85 | 0.85 | 0.05 | 0.05 | 112 | 100 | 92 | 320 |
| 75 | 1,270 | 2.88 | 0.28 | 1.09 | 1.91 | 0.81 | 0.85 | 0.23 | 0.11 | 239 | 162 | 137 | 298 |
| 76 | 1,230 | 3.70 | 2.65 | 2.67 | 2.71 | 1.54 | 0.80 | 0.06 | 0.04 | 102 | 92 | 84 | 183 |
| 77 | 1,280 | 2.67 | 1.06 | 1.71 | 1.77 | 1.20 | 0.71 | 0.23 | 0.09 | 213 | 181 | 135 | 280 |
| 79 | 1,265 | 2.45 | 1.64 | 1.64 | 1.62 | 1.86 | 0.80 | 0.12 | 0.06 | 164 | 147 | 140 | 286 |
| 81 | 1,260 | 2.44 | 1.57 | 1.60 | 1.72 | 2.92 | 0.68 | 0.16 | 0.12 | 168 | 164 | 139 | 291 |
| 82 | 1,270 | 2.55 | 1.71 | 1.67 | 1.71 | 1.98 | 0.85 | 0.10 | 0.07 | 154 | 145 | 128 | 295 |
| 83 | 1,270 | 2.77 | 1.93 | 1.88 | 1.87 | 1.52 | 0.80 | 0.12 | 0.09 | 149 | 140 | 135 | 280 |
| 84 | 1,295 | 2.74 | 1.92 | 1.94 | 2.10 | 2.23 | 0.80 | 0.09 | 0.07 | 151 | 138 | 121 | 296 |
| 85 | 1,300 | 2.55 | 0.02 | 0.09 | 0.18 | 0.69 | 0.68 | 0.18 | 0.12 | 249 | 232 | 205 | 267 |
| 88 | 1,265 | 2.42 | 1.81 | 1.84 | 1.82 | 5.05 | 1.08 | 0.13 | 0.07 | 167 | 159 | 147 | 175 |
| 90 | 1,270 | 2.18 | 1.48 | 1.46 | 1.47 | 3.73 | 1.12 | 0.05 | 0.05 | 185 | 175 | 166 | — |
| 94 | 1,300 | 3.03 | 0.89 | 1.89 | 2.07 | 1.06 | 1.93 | 0.07 | 0.05 | 192 | 135 | 124 | 294 |
| 98 | 1,260 | 3.81 | 2.94 | 2.94 | 2.95 | 1.44 | 1.23 | 0.06 | 0.06 | 106 | 92 | 90 | 204 |
| 100 | 1,245 | 3.70 | 1.90 | 2.47 | 2.61 | 0.75 | 0.96 | 0.32 | 0.05 | 126 | 113 | 104 | 314 |

The cooled samples were subjected to the transverse test, tensile test, Brinell test and microscopical inspection. The Brinell test was taken with the 5 mm. ball and a load of 750 kg. The chemical composition and the hardness figures are given in Table I.

The changes of the Maurer diagram (represented in Fig. 1 by the full lines) as revealed by the microscopical examination may be briefly summarised as follows. Normally-cooled samples: the line AB is displaced to the right by about 0.2 per cent. of silicon on the abscissa; the same is the case with the line AB. These facts were already stated by Maurer on account of other experiments. Besides this the line $AB^1$ does not run to the point A, but at about 3.1 per cent. of carbon it deviates to a direction parallel to the ordinate. The same is the case with the lines $AD^1$ and AD; the end points of these lines on the abscissa are not changed. For samples poured into moulds preheated to 250 deg. C.; the lines of the diagram are not changed, with the single exception that the line $AB^1$ deviates into a direction parallel to the ordinate at about 3.1 per cent. of carbon. This deflection could not be stated in the case of the lines AD and $AD^1$ for want of experimental data. For samples poured into moulds preheated to 450 deg. C. the changes of the diagram are more pronounced. Line $AB^1$ is displaced to the left to such a degree that it coincides with line AB; the latter is displaced too, its endpoint on the abscissa is at about 1.6 per cent. of silicon. At 3.1 per cent. of carbon the line $AB^1$ deviates parallel to the ordinate. The positions of the lines $AD^1$ and AD are also changed; their end points on the abscissa are at 4.9 and 6.25 per cent. of silicon respectively. The deflection of these lines at higher carbon contents could not be stated for want of experimental data. Chill cast samples: the samples with a white fracture extend to the line $AD^1$; the area of the mottled samples is bordered at the right by a line parallel to the ordinate starting from the line $AD^1$ at about 3.1 per cent. of carbon.

From the above results there can be drawn the following practical conclusions. In Fig. 1 the full lines of which represent the original Maurer diagram, there are drawn two dotted lines. The right one borders the pearlitic area of the samples poured into a mould preheated to 450 deg. C. to the right, and the left line is furnished by a casting of 0.315 in. wall thickness, containing 2.90 per cent. of carbon and 1.40 per cent. of silicon, the structure of which was pearlitic. With the aid of the temperature increase of the mould after pouring together with the specific heat and the heat content of the iron it was calculated that the cooling rate of the samples poured into the mould preheated to 450 deg. C. corresponded to that of a sample of 3.54 in. wall thickness. Therefore the area between the dotted lines represents the pearlitic area for castings the wall thickness of which may vary from about 0.394 to 3.54 in. Further experiments are needed to investigate the positions of the lines in the neighbourhood of point A, as in the experiments in question it was not possible to obtain melts higher in carbon than 3.7 to 3.8 per cent.

Furthermore, the microscopic examination showed that the preheating of the moulds exerted the greatest influence on the microstructure of the mottled samples. The experiments of Diefenthäler (Lanz-Perlit) already showed that at definite contents of carbon and silicon a definite cooling rate converts the mottled structure normally obtained to a pearlitic one. In the present experiments the melts which would show a mottled structure under normal conditions are numbered 65, 77, 64, 94, 21, 22, 17, 13, 19, 16, 49, 12, 70, 43, 56, 40, 100. Of these melts the Nos. 65, 77, 21, 56 and 100 show a pearlitic structure when poured into moulds preheated to 250 deg. C. When the moulds are preheated to 450 deg. C. all these melts are pearlitic. In the case where a pearlitic structure is obtained under normal conditions preheating the moulds does not change it, but the size of the constituents of the matrix provided that the carbon and silicon contents do not pass the right of the dotted lines in Fig. 1. With a very high silicon content, the influence of preheating the moulds practically ceases, the amount of graphite remaining constant (melts No. 73 and 88). As to the size of the graphite flakes, the preheating tends to render it more uniform. As to the chill-cast samples, which, as stated above, showed a white fracture up to the line $AD^1$, the microscopical examination revealed the fact that most of these samples also contained graphite in a eutectic-like formation. The graphite

* Stahl und Eisen, 1927. No. 43, pp. 1805/12. No. 47, pp. 1977/84.

eutectic which occurred in the middle of the samples together with the ordinary form of graphite extended to the outside of the samples,

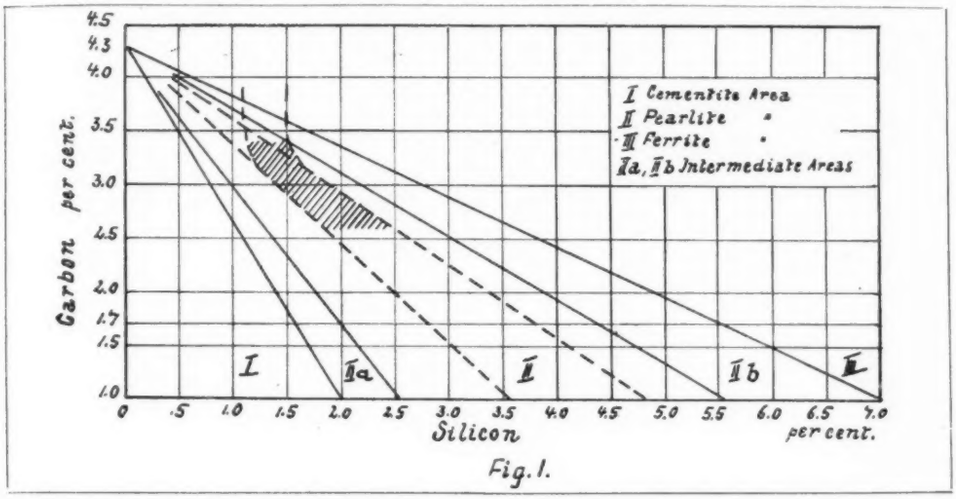


Fig. 1.

when the silicon content was increased though there was no sample which showed the graphite eutectic across the whole cross section. By preheating the moulds the flakes of the eutectic were enlarged, the total amount of graphite remaining constant (No. 98). When a normally-cooled sample showed the graphite eutectic together with the ordinary graphite flakes the latter could not be detected in the chill-cast sample of the same melt. From this fact it may be concluded that the graphite of the eutectic directly separates from the molten iron whereas the ordinary graphite is produced by the breakdown of the cementite. A relationship between the depth of the white outside and the silicon content could not be stated.

The results of the examination of the mechanical properties are given in three diagrams in which the lines of the Maurer diagram are also drawn. From these diagrams it can be seen that the tensile and transverse strengths increase starting from the white to the pearlitic area. When passing from the pearlitic to the ferritic area there occurs a decrease of the mechanical properties which at a carbon content of below 3.1 per cent. begins just before or in the transition area IIb; when the carbon content is above 3.1 per cent. the decrease already begins in the pearlitic area. As to the influence of preheating the moulds it could be stated that with the exception of the curves in the range of 3.4 to 3.8 per cent. of carbon the mechanical properties of the samples poured into preheated moulds are higher than that of the normally cast samples in the areas I and IIa of the Maurer diagram. The reverse is the case with the samples the composition of which correspond to the areas II, IIb and III. In the Tables II and III there are recorded the highest values of the mechanical properties; Table II shows that the highest values of the tensile strength are connected with the pearlitic matrix; this is not the case with the transverse strength, as is seen from Table III. By comparing the mechanical properties of the normally cast samples, which showed a pearlitic structure with that of the samples the structure of which became pearlitic by preheating the moulds it was found that in both cases the tensile strength and the transverse strength are the same, whereas the deflections of the preheated samples show higher values than that of the normally cast samples. From the hardness figures which are

TABLE II.

| Range of Total Carbon Per cent. | Sample No. | T.C. Per cent. | C.C. Per cent. | Si. Per cent. | Tensile strength. t/sq. in. | Structure. |
|---|---|---|---|---|---|---|
| From 2.4 to 2.6 .. | 81 | 2.44 | 0.87 | 2.92 | 17.45 | Pearlite + some Ferrite. |
| ,, 2.7 ,, 2.9 .. | 26 | 2.7 | 0.91 | 1.36 | 18.48 | ,, + some Cementite. |
| ,, 3.0 ,, 3.2 .. | 22b | 3.08 | 0.86 | 0.93 | 19.23 | ,, ,, ,, |
| ,, 3.2 ,, 3.4 .. | 8 | 3.24 | 0.94 | 1.39 | 18.22 | Pearlite. |
| ,, 3.4 ,, 3.6 .. | 15b | 3.45 | 1.18 | 0.77 | 17.22 | Pearlite + some Cementite. |
| ,, 3.6 ,, 3.8 .. | 66 | 3.67 | 1.09 | 0.79 | 12.25 | Pearlite. |

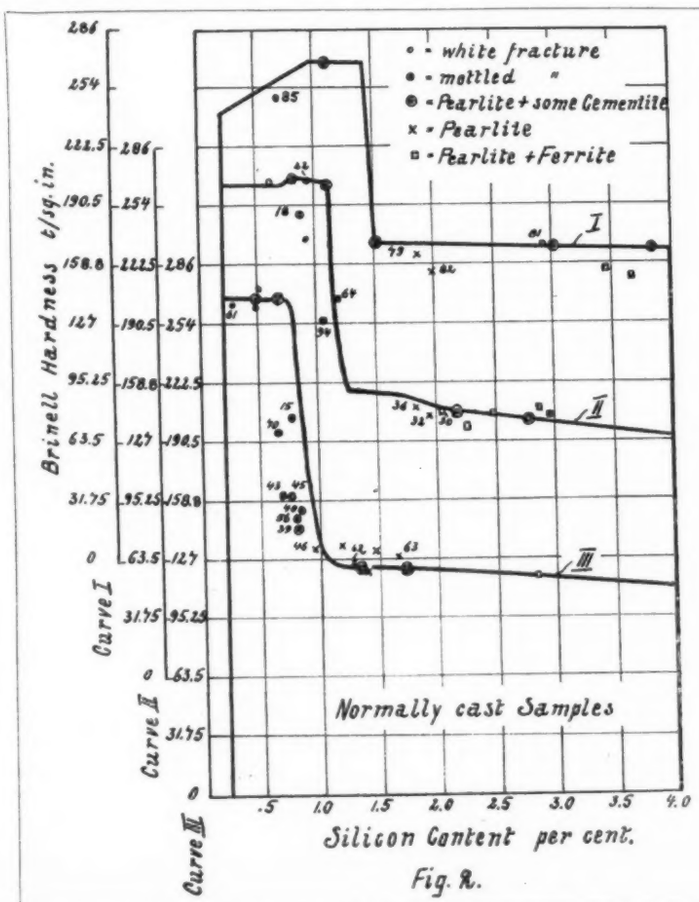


Fig. 2.

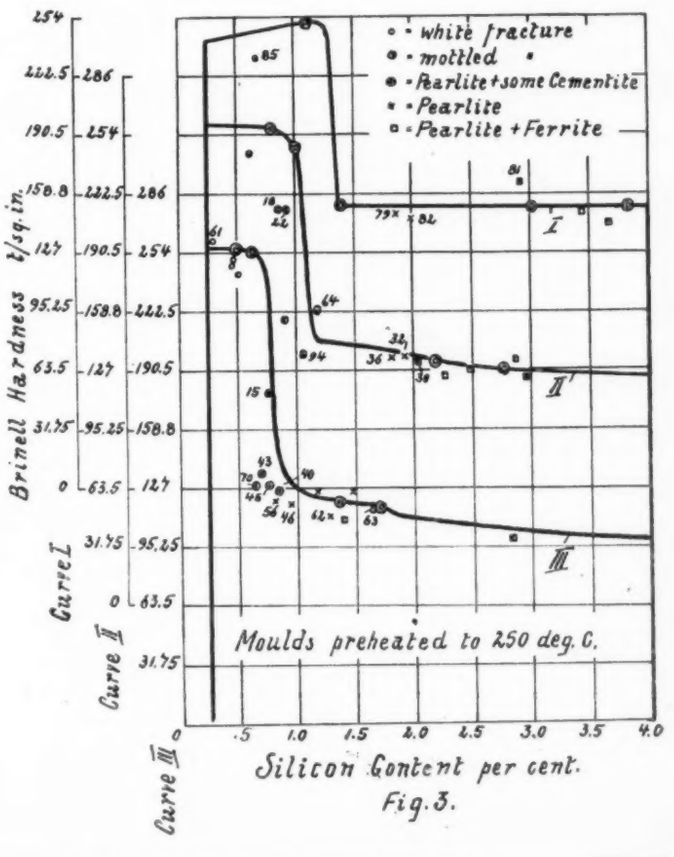


Fig. 3.

given in Table I there were constructed "room" diagrams, of which four photographs are given. Figs. 2 to 4 show the intersection curves of these "room" diagrams at the following carbon contents: 2.5 per cent. (curve I), 3.0 per cent. (curve II), 3.5 per cent. (curve III). To ensure a better view the three curves are displaced from each other by a Brinell number of 63.5 t/sq. in.,

Table III.

| Range of Total Carbon Per cent. | Sample No. | T.C. Per cent. | C.C. Per cent. | Si. Per cent. | Tensile strength. t/sq. in. | Structure. |
|---|---|---|---|---|---|---|
| From 2.4 to 2.6 .. | 85b | 2.55 | 2.36 | 0.69 | 32.4 | White. |
| ,, 2.7 ,, 2.9 .. | 31b | 2.82 | 1.40 | 0.98 | 32.7 | Mottled. |
| ,, 2.7 ,, 2.9 .. | 65b | 2.69 | 0.93 | 1.24 | 32.7 | Pearlite. |
| ,, 2.7 ,, 2.9 .. | 59a | 2.70 | 0.84 | 1.63 | 32.7 | ,, |
| ,, 3.0 ,, 3.2 .. | 22b | 3.08 | 0.86 | 0.93 | 33.85 | Pearlite + some Cementite. |
| ,, 3.2 ,, 3.4 .. | 14 | 3.35 | 1.08 | 1.11 | 31.6 | ,, ,, ,, |
| ,, 3.4 ,, 3.6 .. | 39 | 3.42 | 1.18 | 0.82 | 31.75 | ,, ,, ,, |
| ,, 3.6 ,, 3.8 .. | 57 | 3.64 | 3.60 | 0.48 | 26.7 | White. |

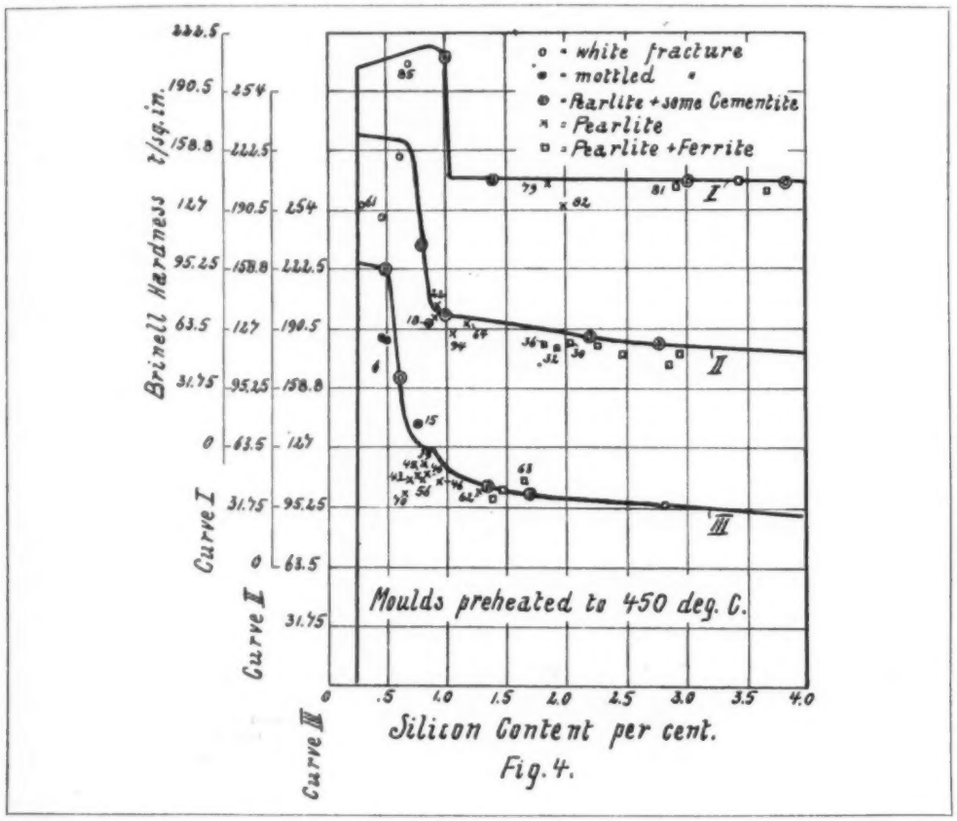

Fig. 4.

as can be seen from the scales at the left side of the diagrams. The intersection points of the lines of the Maurer diagram with the curves mentioned above are marked by double circles.

**Nickel in Greece.**—The "Gazette Officielle" of Athens publishes a decree ratifying the convention between Greece and the Middle East Development Corporation for the establishment in Greece by the Company within eighteen months of a nickel industry with a production of at least 500 tons of nickel annually.

**Internal Stresses in Cast-Iron.**—At a meeting of the Académie des Sciences, held on November 21, M. Leon Guillet presented a paper from M. Le Thomas, of the Naval Establishment at Indret, on "The Elimination of Stresses in Iron Castings." These internal stresses are very dangerous, and are often the cause of serious fractures. M. Le Thomas has experimentally discovered a process for their removal by heat treatment. He recommends a slow heating to 650 deg. C., with equally slow cooling, when the internal stress totally disappears.

## The Segregation of Aluminium-Copper Alloys.

Previous investigations on the segregation of Al-Cu alloys, which were carried on by Bauer and Beck, with alloys containing 1.0, 3.5 and 4.0 per cent. of copper respectively, showed that in such alloys there occurs an inverse ingot segregation, i.e., the copper content continuously decreases, starting from the outside to the centre of the sample. Recently W. Claus and B. Dango* made

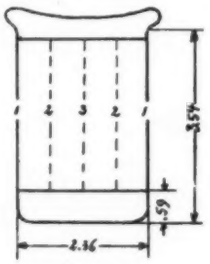

Fig. 1.

experiments with the American alloy containing about 8.0 per cent. of copper, as they were of opinion that the segregation might perhaps be responsible for the failure in mechanical strength which occurs very often with this alloy.

* Zeitzschrift fur Metallkunde, 1927, No. 9, pp. 358/60.

The alloy was molten in a graphite crucible in a gas-fired furnace, the atmosphere being oxidising. At 680 deg. C. the alloy was poured into a dry-sand mould. The two samples were allowed to stand until they showed room temperature; then the bottom and the top of the samples were cut off (Fig. 1). The copper contents of different layers of the samples were examined by electrolysis; the results are given in Table I. The bottom

Table I.

| Layer. | Copper, per cent. | Sample No. |
|---|---|---|
| 1 | 8.36 | I. |
| 2 | 8.12 | I. |
| 3 | 8.36 | I. |
| 1 | 8.30 | II. |
| 2 | 8.12 | II. |
| 3 | 8.48 | II. |

was microscopically examined, but a difference in the amount of the eutectic surrounding the aluminium crystals in the different layers could not be stated. The Brinell test, too, showed no differences in the hardness figures as may be seen from Table II. The results of the present experiments are in contradiction to those of all previous

Table II.

| Layer. | Hardness, t/sq. in. | Sample No. |
|---|---|---|
| 1 | 45.1 | I. |
| 2 | 45.1 | I. |
| 3 | 45.1 | I. |
| 1 | 45.1 | II. |
| 2 | 45.1 | II. |
| 3 | 45.1 | II. |

investigations, which showed either a plane "normal" or an "inverse" segregation. From the chemical analysis it may be concluded that in the present case both the kinds of segregation take place. Two other ingots which were poured at 780 deg. C. into moulds preheated to 350 deg. C. gave the same results, as may be seen from the Tables III and IV. The present experiments show that an enriching of the Al-Cu-eutectic takes place

Table III.

| Layer. | Copper, per cent. | Sample No. |
|---|---|---|
| 1 | 8.42 | III. |
| 2 | 8.36 | III. |
| 3 | 8.84 | III. |
| 1 | 8.24 | IV. |
| 2 | 8.04 | IV. |
| 3 | 8.70 | IV. |

Table IV.

| Layer. | Hardness, t/sq. in. | |
|---|---|---|
| 1 | 45.1 | III. |
| 2 | 45.1 | III. |
| 3 | 45.1 | III. |
| 1 | 45.1 | IV. |
| 2 | 45.1 | IV. |
| 3 | 45.1 | IV. |

at the outside and the centre of an alloy containing 8.0 per cent. of copper, but according to the chemical analysis the amount of the segregation is not so great as to affect the mechanical properties in a considerable manner, especially in castings of a wall thickness of 0.2 to 0.4 in., usually made in practice. As to the segregation process itself, there may occur a normal ingot segregation in the beginning (an increase of the copper content from the outside to the centre), which afterwards is followed by the inverse segregation on account of the shrinking pressure which presses the remaining liquid, rich in copper, into the interstices of the crystals in the outer layers.

# Cupola Melting with Special Reference to the Value of Steel Scrap in Cupola Mixtures.

By W. Dennison.

One frequently notices references to the inefficiency of the cupola as a melting unit. These criticisms are, presumably, in reference to its thermal efficiency and suggest that improvement is possible. But allowing that the total heat of the metal at its tapping temperature in percentage relation to the calorific input as represented by the coke consumed is low, such a consideration is completely dwarfed from a metallurgical point of view by the value of the compensating mechanism of the chemistry of cupola melting. Many ironfounders, particularly those who, because of the smallness of their establishments or from pseudo-economic views, do not have laboratory control, should regard the cupola as a valuable, though inanimate, friend.

To obtain the correct perspective of this matter, it is important to realise that, within fairly wide limits, the elements or, more properly, constituents of cast iron are not to be regarded as impurities but as essentials. These essential constituents have been providentially provided by Nature, whose laws have ensured of their wise selective retention throughout the smelting and melting processes of the blast furnace and the cupola. The general run of native iron ores contain, within almost the desired limits, the very elements that bestow on cast iron its *raison d'être*.

Cast iron, therefore, as far as man is concerned is, in the first place, accidental, and one wonders what the metallurgical progression of cast iron would have been had it been otherwise. The constituents were there, and the question was, what was their influence? The classical researches of Turner on the influence of silicon and of Stead on the influence of phosphorus provided the ironfounder with information that allowed him to control the analysis of his mixtures as far as these elements were concerned with understanding and reason. But what would have been the position if the maximum phosphorus content of ores had been no more than that existing in low phosphorus hematite, which yields pig-iron containing 0.06 per cent. phosphorus? The ease with which light and intricate castings, which form a large portion of the castings made with cupola metal to-day, are poured with, say, 1 per cent. phosphorus cast iron, would only have been evolved after much research. Even then, the phosphorus additions would have had to be made in furnace burden, cupola charge or ladle and at much expense. As evidence of Nature's kindness to the founder this example is particularly outstanding.

At the present time the cupola comes under the castigation of the low total-carbon school of metallurgist. That cupola melting tends to facilitate carbon absorption to the eutectic composition is the *bête-noir* of the low carbonists. Low total-carbon, which is usually reflected in small-size graphite, along with a suitable balance of composition, yields a high-grade iron with valuable physical characteristics, which make it very suitable for the manufacture of a number of castings for which modern engineering has given the demand. However, such a metal is not only unnecessary but unsuitable for the manufacture of the general class of grey iron castings in which direction our defence of the cupola is aimed.

### Densities and Shrinkage.

Cast iron, in the molten state, has a specific gravity of about 6.7, and as all of the carbon (except, possibly, traces of undissolved graphite) is in the combined form before setting, the variations found in commercial iron do not influence the liquid density except in a small degree. The specific gravity of cast iron at normal temperature, however, varies from 7.0 to 7.7, these limits being the specific gravities of the greyest and whitest specimens. From these figures it may be deduced that an equal weight of molten iron may lose anything from 5 to 15 per cent. of its volume in setting according to its composition. Generally, the closer and stronger the metal the greater the diminution of the volume from the liquid to the solid state, and the greater the amount of metal necessary to be fed by means of the pouring basins, "masselottes," sprues and risers to the casting proper.

From this it is apparent that when the gates and feeding basins have been standardised for a certain casting for which a certain composition of metal has been proved to be best suited it is important that the cupola should deliver such a metal, or at least, a metal having similar thermo-physical characteristics. As is later explained in this article, the cupola really does its best to overcome the vagaries of melting by balancing the chemical composition so that the physical properties are those required.

### Mixture Control.

The elements which the worker responsible for the mixtures of a normal grey-iron foundry attempts to control are silicon, phosphorus and manganese. Good melting results in a loss of 10 per cent. of the calculated silicon and about 15 per cent. of the calculated manganese. The phosphorus is very slightly increased due to the absorption of a little from the coke ash and by concentration due to the melting loss. But in practice the calculated losses of the silicon and manganese frequently go astray. This may be caused by atmospheric conditions, inefficient charging, bad sampling, or, in case of rule of thumb foundries, pig-iron not to specification. These are the conditions which the compensating mechanism of the cupola alleviates.

For example, it will be assumed that very good results are obtained when pouring a certain casting with metal of the following composition:—T.C., 3.41; Si, 2.25; Mn, 0.85; S, 0.08; and P, 0.85 per cent.

In aiming for this analysis the calculated charge would contain 2.48 per cent. Si and 1.0 per cent. Mn. Now, if for some reason the factors of the calculation are wrong or excessive oxidation occurs, with the result that the silicon is considerably lower, the solubility of the iron for carbon will increase and the cupola condition will facilitate an absorption of carbon which will very nearly compensate physically for the extra loss of silicon. Thus ironfounding is made much easier than would be the case if chemical affinities and the cupola were not so favourable. The resultant metal may have only 1.8 per cent. Si and 0.65 per cent. Mn—the excessive oxidation of silicon and manganese is usually parallel—but the increase carbon, say, 3.60 per cent., will help to give the same physical characteristics as the desired analysis aims at. Without the help of the extra carbon in the form of graphite, the type of casting in question would most probably suffer from shrink and would be deemed hard from the machine-shop standard.

The oxidation losses of Si and Mn when melting a mixture containing a relatively high percentage of steel scrap are usually higher than the 10 per cent. and 15 per cent. afore quoted, and here the compensation of carbon absorption proves very useful when low total carbon is not the desideratum. The oxidation of the silicon is particularly irregular with such "semi-steel" mixtures, and is sometimes explained by the presence of thin oxidised sections of steel in the scrap. However, when the scrap is reasonably clean, the silicon loss is liable to exceed the 10 per cent. of ordinary grey-iron mixtures. The explanation partly lies in slight oxidation of the Fe of the steel as it first melts with subsequent reaction of this oxide with the silicon. Certainly one usually finds silicon pig or ferro-silicon handy for use wherever a good deal of steel is used in the mixture. The writer has particularly noticed this in French foundries.

### Heredity Characteristics of Pig-Iron.

That cast irons of identical composition can have different mechanical properties has long been discussed. By "identical compositions" is presumably meant "identical ultimate compositions," which may be a very different thing. However, conclusive evidence is absolutely non-existent as far as proof of the good or bad "inherited" properties of particular irons are concerned. Generally, in quoting examples, one or other of the common constituents are omitted, the inclusion of which will generally explain the difference in physical properties. Again, there are so many factors of influence in the successful making of castings that when the foundry strikes a bad patch of mysterious losses, the human tendency is to put the blame on some particular brand of pig-iron. This brand is consequently taken out of the mixture and the losses coincidently resume the normal. This is sufficient evidence of the brand's bad qualities to some minds, and it is certainly an easy way of dismissing the matter, but it is not scientific.

The writer has had such experience, and the further experience of surreptitously replacing the same brand in the mixture without increasing the loss of castings. In fact, in the case quoted the loss, by a coincidence, became slightly lower than normal for a week or so.

At the present time the hypothesis that graphite can pass through the melting stage without being totally dissolved is being expounded by various authorities. These finely divided particles of graphite are said to form nuclei around which large flakes of graphite are formed. It will be evident that if this is so that the higher the graphite carbon of the cupola charge, that is, the nearer the average percentage to the eutectic for the particular composition of the mixture, the greater will be the chance of some of the graphite passing through undissolved. This is, of course, apart from any physical characteristic which the graphite of some of the pig-iron may have assumed and which characteristic opposes easy solution in the Fe. There is no proof or reason to assume that such a characteristic exists.

It is the writer's opinion that this hypothesis of graphite nuclei existing under certain conditions is very helpful and logical in explaining the phenomenon of varying graphite size which undoubtedly occurs in irons of similar composition that have apparently received similar thermal treatment.

### How Steel May Help Complete Graphite Solution.

It is generally claimed that the use of steel scrap in a cupola mixture has a beneficial influence in reducing the size of the graphite flakes in the resultant castings. This is apart from any diluting action on the usual pig-iron constituents, which in the case of the controllable elements, silicon, phosphorus and manganese, could just as easily be obtained by the use of suitable pig-iron. As far as carbon is concerned, the diluting action of steel is not very effective, as the cupola offers every facility for absorption of carbon from the coke to the eutectic composition. It is generally found that for the purpose of calculation of the ultimate carbon content, the steel quota of the charge can be considered as containing 3 per cent. carbon.

As the carbon eutectic for an average commercial grey iron is about 3.5 per cent., it will be seen that a very high percentage of steel must be used to obtain any appreciable benefit from a reduced carbon content. Thus, if any advantage in strength and soundness is obtained by the use of steel, it must be chiefly of a physical nature. Here it may be said that we are referring only to straight carbon steels which rule out the influence of special alloy elements.

Whereas the writer is still of open mind regarding the variable qualities of pig-iron, composition for composition, he is quite willing to add his testimony to that of other steel users regarding the "smaller graphite influence" of steel scrap on the resultant metal, composition for composition.

The inference is that the steel acts by preventing the retention of undissolved graphite in the bath of molten metal. During the melting of the steel, and while trickling down through the bed, the molten drops of the original steel become richer in carbon by absorption of the latter from the fuel. On reaching the bath the molten steel has still less carbon than the metal on the hearth, and what is more, it is practically free from silicon,

manganese and phosphorus, and consequently possesses quite different physical characteristics. It is, in fact, a hypereutectic steel, whereas the bath contents are those of a grey cast iron. Furthermore, the picking up of the carbon in the formation of carbide as represented by the equation $Fe_3 + C = Fe_3C$ is an exothermic reaction the heat of formation of which is fully utilised internally in the superheating of the molten drops of carburised steel. On entering the bath the constant stream of these drops of superheated high carbon steel upsets the equilibrium and gives rise to a more than ordinarily active bath, the temperature and circulation of which provide the mechanics for complete graphite solution.*

Such a virile bath also helps to explain the extra loss of silicon and manganese occurring with the use of steel scrap. The slag is more active and the oxidation further increases the superheat which Piwowarsky has shown is favourable to the complete solution of the graphitic carbon and the absence of graphitic nuclei.

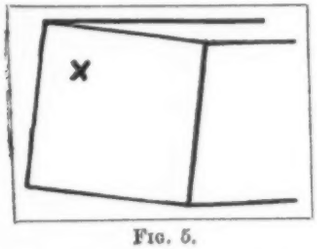

Fig. 5.

* The same consideration applies to that metal—steel and grey iron—which mixes in descending through the bed.

**Structure as Shown by Microphotographs.**

The microphotographs, Figs. 1, 2, 3 and 4 are of particular interest, as they clearly show the different structures of two grey cast irons of reasonably similar chemical composition. The mixture represented by Figs. 1 and 2 contained no steel, whereas the mixture represented by Figs. 3 and 4 contained 18 per cent.

The thermal treatment as far as cupola practice, pouring temperature and cooling rate were concerned was, as near as practice allows, the same. The pictures were obtained from 1 in. square bars at the position shown on Fig. 5. This position may be considered to give a mean indication of the structural composition.

Fig. 1.—× 60 Unetched.

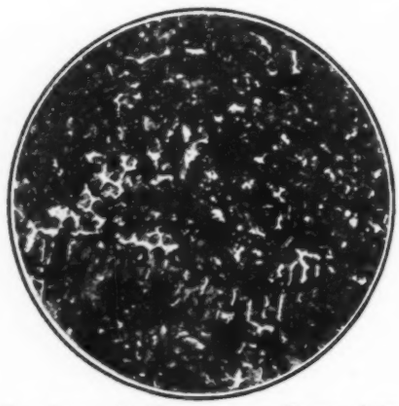

Fig. 2.—× 60 Etched with Picric Acid.

Fig. 3.—× 70 Unetched.

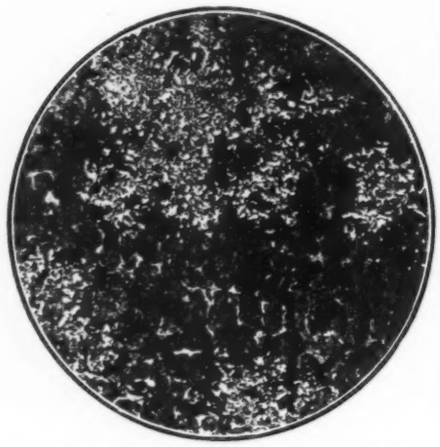

Fig. 4.—× 70 Etched with Picric Acid.

The structures are typical of a large number of micrometallurgical studies made over a period of several years. Further, the transverse strengths of the 1-in. square bars between 12-in. centres are typical of the two classes of metal. The chemical analyses and transverse loads at fracture of the two examples are appended:—

| | No Steel. | 18 per cent. Steel. |
|---|---|---|
| Total Carbon ... ... | 3.45 | 3.40 |
| Graphite Carbon ... | 2.90 | 2.91 |
| Combined Carbon ... | 0.55 | 0.49 |
| Silicon ... ... ... | 2.20 | 2.35 |
| Manganese ... ... | 0.57 | 0.65 |
| Sulphur ... ... | 0.098 | 0.058 |
| Phosphorus ... ... | 0.74 | 0.63 |
| Transverse Strength ... | 2,410 | 2,980 |

It will be noted that the microphotographs of the bar representing the steel mixture show that the graphite is very finely divided, whereas the microphotographs of the bar representing the mixture without steel show the graphite to be coarser and of an elongated form.

In concluding, the writer claims (although the term "semi-steel" is justifiably derided by metallurgists) that the use of steel scrap in a cupola mixture has a beneficial influence on the physical properties of the resultant metal even when the chemical composition gives no indication of such improvement.

The percentage of steel used to obtain the best results will vary from 5 per cent. for the lightest of castings to 40 per cent. for the heaviest. Of course, the balance of the mixture must be carefully selected, and for this reason foundries without laboratory control usually hesitate to use the economical and effective raw material, steel scrap, in their mixtures.

## Company Meetings.

**John I. Thornycroft & Company, Limited.**—Sir John E. Thornycroft, presiding at the 26th annual meeting, said that the year's profit amounted to £65,626, and there was a total sum available of £116,919. It was proposed to pay a final dividend of 3 per cent. on the Cumulative Preference shares, making 6 per cent. for the year, 7½ per cent. on the Preferred Ordinary shares, and 6 per cent. on the Ordinary shares, and to carry forward £51,669. Although there had been an improvement in the results from the shipbuilding and marine engineering side of the business, they had passed through another year in which these works had contributed nothing towards the dividends.

**Shotts Iron Company, Limited.**—At the annual meeting, in Edinburgh, on December 5, Mr. Alexander Wallace, the chairman, intimated that by-product works had been acquired, and were being reconstructed at Shotts at a cost of £14,000, and a washery was being erected at Loanhead Colliery at a cost of upwards of £20,000. Electrical plant was being installed at several collieries. The coal industry at present, he said, was in a very deplorable position. The company were putting out little more than half of their usual output and trying in every way to secure economy, and yet they were still losing money each month. The loss was not large, but even a small monthly loss could not go on continuously. The coal strike of last year caused the country a great loss of output of coal, and since work had been resumed they found competition in selling coal where before there was no competition.

**Sheffield Steel Products, Limited.**—The sixth annual general meeting was held at Sheffield recently. The chairman (Mr. C. P. Johnston), in moving the adoption of the report and accounts, said: It is a matter of common knowledge that the general trade of the country has been in a very depressed state during the whole of the year under review. I do not think any of us, and least of all our managers, who have had to face day by day difficulties of no ordinary nature, have any desire to go through another year of a similar character, and it is a matter of great satisfaction to your directors to be able to report to you that since the beginning of the present financial year there has been an improvement of a satisfactory character. The estimated returns for the five months of June, July, August, September and October show an increase in sales of about 15 per cent. over last year, while each month's returns show a progressive profit, as against substantial losses last year.

**Dorman, Long & Company, Limited.**—Sir Arthur Dorman, chairman, addressing the shareholders on December 6 on the general trade outlook, said there had been a change for the better during the past year. Greater financial stability on the Continent was having its effect towards releasing the block which for so many years had held back the free flow of international trade and international values, which were approaching more closely towards one another, and altogether there were signs evident that easier times might be looked for in the next few years by those export trades which have suffered so long and so severely through the more rapid policy of deflation pursued by this country, as compared with our Continental neighbours. "By rigid internal economy," he said, "it lies within our power to anticipate and to add materially to the assistance which will, in course of time, offer to our export industries. I see no sign of anything of the kind," added Sir Arthur; "extravagance is rampant in every form of life—public and private. Luxury and amusement of a kind undreamt of before the war have become part of the daily life of the country. While internal prosperity was a thing eminently to be desired, we could not afford a level of internal prosperity which threatened seriously to interfere with our export trade. Unless export trades were prosperous it was only a matter of time before the present artificial internal prosperity must come to an end."

# Foundry Practice in the United States of America.*

By E. Longden.

During the last decade there has been considerable examination and thought brought to bear upon the production methods practised in the U.S.A., which has been responsible for that nation's prosperity and state of well-being never reached before. Without doubt America has led the way in the development of a new industrial era. For the last thirty years the Americans have been deeply engaged in organising, originating, improving and bringing into action industrial machinery which manufactures more products and wealth per head of the population than any other nation in the world. They have developed mostly on original and independent lines, and have made such a great success of their industrial methods by ignoring the philosophy of the older countries.

In the States they have developed high production, high remuneration and, of course, from this, high consumption. This fostered system, which is the basic principle of industry, has meant that there has been more wealth to divide among the inhabitants of the country. They early learned that power, machinery and organisation of business and manufacturing establishments on a large enough scale, and with sufficient capital to afford and put down the best plant possible, was the way of real progress. They have installed, and are continuing to place as much machinery at the service of the workers as possible. Probably there is between three and a half and four horse-power at the service of every worker in the United States of America. This vast amount of mechanical aid is staggering, and is generally the rule. They introduce labour-saving devices and machinery almost to the maximum possible, not only in specialisation and mass-production foundries, but also in those engaged in general engineering castings. They prefer to err on the side of over-mechanicalisation than otherwise. A remarkable proof of the industrial progress can be measured by the returns of the last 5 years or so, which show that the production has increased at the rate of 10 per cent. per annum, whilst there has only been an increase in labour supply of 3 per cent.

The evolution of the peculiarly American methods of production form part of the larger policy of the engineering industry as a whole, which is to specialise as much as possible for mass production.

But it must not be thought that the mechanical aids are absolutely dependent on mass-production demands. Production on a large scale of engineering castings allows of many innovations in the application of machinery which is little thought of in this country.

American methods of production have placed increased earnings in the hands of the consumers, which means more purchasing power and demand for food, goods and services. It is a very happy cycle, and one which many of our most progressive business men and captains of industry would welcome.

It is, of course, obvious that the U.S.A. has been considerably aided in the great industrial developments by the location and self-contained nature of the country. There is scarcely anything they need to purchase outside their own borders.

The American worker as a whole produces far more in a given time than the British worker. By this it is not inferred that he can necessarily work harder. The system encourages the worker to give his maximum production. He is comparatively very happy and prosperous. This thought is commended to those British trades unionists who believe and teach the economic fallacy that increased production per head means only more profits for the "bosses" and more unemployment for the workers. The U.S.A., with high production, high wages and high consumption has well beaten those nations with low production and low wages.

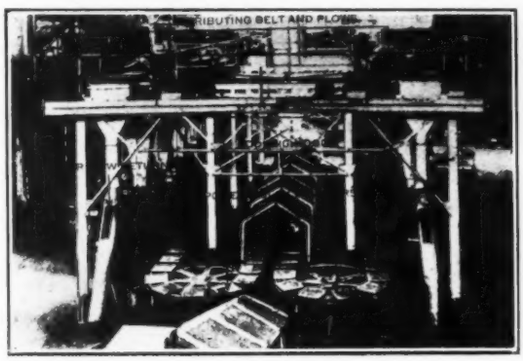

FIG. 1.

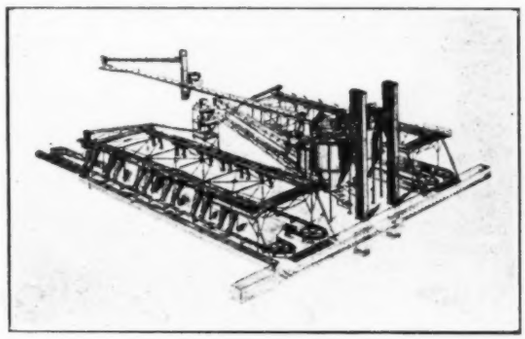

FIG. 2.

There is a great responsibility resting on the shoulders of British business men and captains of industry to improve generally manufacturing methods and to place at the service of the worker at least as much horse power as in the U.S.A. They have been extremely slow in reception of the broadcasting by the Americans themselves of their methods of manufacture and team work, also the exchanging of ideas through associations, conventions, and talks as they say over the other side.

At the various functions attended by those of us who visited America last year, it was very evident that there was a constant theme running through the speeches of those intellectual and vigorous leaders of industry who acted as hosts, which was a request to open our eyes and emulate them in methods of peaceful production, and that we should believe in their deep concern for the outlawry of war. The extensive tour of the American foundries undertaken last year by European foundrymen was of an illuminating character. As a nation Germany sent the largest proportion of delegates, and it was very obvious that they were keen business and technical men who would quickly grasp and carry back to their country production methods later to vie with the Americans themselves. It is also up to us to adopt the industrial philosophy of the U.S.A.: otherwise we shall still further decline in importance as an industrial nation. It is very evident that it pays to specialise and produce on a large scale.

### Industrial Combinations.

How is it that firms in this country, and of a like manufacture, do not combine? For instance, we have a number of engineering companies each manufacturing half a dozen or more lines of products, such as gas and oil engines, steam engines, hydraulic machinery, pumps, machine tools, etc. Another group may be making machinery for agricultural work, and each firm may make separately oil engines, mowers, reapers, root cutters, seed-crushing and food-cake implements. There are textile engineering companies each producing such as carding engines, combers, mules, speed frames, etc. Many more groups could be cited, each member working in isolation and more or less in competition.

The author ventures to state that given good clear-cut combinations and associations of firms who are at present of a competing manufacture a great fall in costs of production would result, and consequently give more production per head and more wealth to divide between manufacturers and workers and a cheaper and better product for the consumer.

Are British companies so conservative that it is not possible to form associations and each member of the group have allocated to them one, or perhaps two lines of manufacture best suited to the layout, location of works and reputation for a certain product? There appears to be no reason why a large proportion of our manufacturers could not be so organised to produce on the same lines as practised by Ford and many others in America and Morris and Austin in Britain.

### Vocational Training.

Due to restricted emigration by law there has been a steady drying up of the influx of skilled artisans into the U.S.A. This restriction has given a great impetus to the vocational training of the youth of that country. They have quickly realised that if they are to maintain industrial supremacy that they must train apprentices vocationally as well as educationally.

Whilst the visitors were being conducted round the Carnegie Technical College at Pittsburgh one of our guides stated that: "The best way to learn anything which has to be done and practised after it has been learned is to be doing whilst we are learning." This is the right outlook for any industrial training. Even in times of depression vacancies for skilled moulders and other artisans are difficult to fill.

A British worker—by what is loosely termed either hand or brain—can quickly obtain a superior livelihood in America, and the proportion of Britishers in advanced positions is very gratifying. After viewing the cosmopolitan races employed in the American foundries and from information willingly tended we can be sure that the British skilled jobbing moulder has no superior in the world.

One hears of comments made by certain employers in this country that they cannot secure good foundry executives. This is a libel on British foundrymen. The author is aware how the American captains of industry would treat such men as exist both inside and outside the Institute of British Foundrymen in various parts of Britain. It is a fact that in the U.S.A. it is almost impossible for intelligence or craftsmanship to go unrewarded. Men of ability are given a chance to make good. They eventually make up

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. Primrose presiding.

the leaders and managers of industries which are filled with staffs of mixed nationalities.

Contrary to biased opinions the Americans welcome to their shores the British manual workers, thinkers and research workers. The scientists are requested to commercialise their knowledge at the earliest opportunity.

### Methods of Production.

*Moulding.*—There is little to learn from the Americans in the actual moulding of general

Fig. 3.

engineering and jobbing castings. The methods practised are almost identical with ours.

In several foundries it was noted that semi-permanent moulding was practised by building soundly bricked-up moulds to be faced by loam. In a foundry making large acid pans of about 22-ft. dia. in loam the inside of the pan was formed by six separately-bricked segments. Each segment was so constructed to allow of repeated use. As an aid to contraction about 3 in. of weak loam was allowed between each portion. The segments were attached by bolting to a strong top plate. After casting, it was only necessary to loosen the holding-down tackle and the bolts supporting the segments. Except for a slight raising

Fig. 4.

of the heavy top plate nothing further was done to allow the casting to contract. This is not at all unfamiliar in Britain.

Considerable use was made of pneumatic rammers, although the author is as yet unconvinced of the utility of using such rammers except for consolidating sand around heavy-casting moulds which have been placed in pits for casting and flat ramming the face of the sand in moulding boxes of large area. Sand slingers were employed in many of the heavy jobbing foundries visited, and were apparently being well used and giving satisfaction. Moulding machines were employed for jobbing castings of small quantities. Considerable use was made of spraying machines to blackwash loam and dry-sand moulds. There seems to be a more common use made of green-sand cores for medium castings than in this country. It was surprising to note the production of comparatively large steel castings in green sand. The sand used was a clean silica sand of a fairly large grain and bonded by a special binding material.

### Mass Production Methods.

*Moulding.*—The advanced mechanical foundries making small and medium repetition castings will have matured from the minds of foundry engineers who conceived the idea of cutting up the various operations necessary to the production of a casting so that a number of specialists would be engaged each to do one set operation instead of the many which are necessary to create a casting. It would be early thought that super-efficiency could be obtained by confining the moulder to actual moulding only, coremakers to making cores, fettlers to dress castings, sand mixers conditioning and preparing sand, casters to pour moulds, and labourers to knock out moulds after pouring. To allow the maximum effort, each grade of labour must move as little as possible from a limited and defined area, and to allow this, all materials and tackle must be delivered and despatched to and from the worker by mechanical means, and for the coremaker and moulder to use as much as possible other mechanical aids, such as core and moulding machines.

There are several firms in America who have made a great success in the manufacture of sand mixing and materials conveying, elevating and handling machinery, whilst others have devoted their plant and time to perfecting moulding and coremaking machinery with equal success.

A number of the visitors were fortunate in having the opportunity to visit one of the works of the Link Belt Company, in Chicago. They have been extremely successful in the mechanicalisation of many foundry operations. This firm has gained a well-deserved reputation in the States for the manufacture of sand-mixing, elevating and conveying equipment of all kinds. Such machinery has now reached a very reliable stage of utility, and is free from serious breakdown, although in many cases running day and night.

Conveying equipment was seen still in effective use, although constructed more than thirty years ago. The whole of the production of many foundries is completely handled by elevating and conveying machinery. Practically every known type of moulding machine was seen in operation, and was mostly employed in conjunction with materials handling plant specially designed for the layout of the foundry. The object of the systems is to secure a continuous moving and timed sequence of operations.

Take as a first example a continuous system whereby a plate pattern and moulding machine with moulding box located and mounted on a small carrier proceeds first to facing sand, then to backing-sand hoppers. The surplus sand left after ramming is butted and cleaned off automatically in the passage of the carrier and moulding box along the conveyor. In its further journey the pattern is extracted, mould finished, cleaned, and passed on to a casting conveyor close to the cupolas. An escalator moves at the same rate as the mould conveyor, and the men who pour the mould stand thereon during the casting process. After pouring, the moulds pass along a cooling length, and sometimes through a cooling hood. After traversing the cooling area, the moulds are knocked out in what is termed a shake-out area. Castings are sent on a conveyor to the dressing department, and moulding boxes pass on to complete the cycle and return to the moulding-machine station.

In many cases sand slingers are used in conjunction with pattern-drawing machines. After the patterns have been drawn, the moulds then pass from side moulding machines to gravity conveyors, and then on to a series of large turn-tables, which serve to pass the moulds to the pouring section, and also return flasks to the moulding station.

Figs. 1 and 2 show respectively a photograph and diagrammatic view of a mechanically-equipped foundry in Cleveland, Ohio. It will be clearly seen by the illustrations that the system is highly efficient for making castings within the limits of moulding machines and carriers.

Fig. 1 shows the shake-out end of the continuous unit with the combined cooling arrangement in the centre, and cantilever method of supporting hoppers to give clear space at the moulders' station. The moulding machines are arranged along each side of the unit, as shown in the illustration. Fig. 2 shows full details diagrammatically.

Fig. 3 shows part of another continuous system. A section of a drag-type mould conveyor is seen in the foreground, and four men stationed at the power moulding machines. Above their heads are

Fig. 5.

sand shutes, which allows a definite amount of sand to fall directly into the flask. The shutes are connected with hoppers, which are filled with sand by bringing into action a plough, which deflects the material from the distributing belt. Fig. 4 shows how a plough deflects the sand from the distributing belt into the sand bin above the heads of the moulders.

### Bath Tubs in Quantity.

Fig. 5 shows a section of a foundry making bath-tub castings. Sixty castings per day are made by fourteen men using ten flasks. In the ordinary way of moulding, sixty flasks would be required, and about twenty-four men and twice the moulding-floor area. Fig. 6 illustrates diagrammatically the system, which consists of

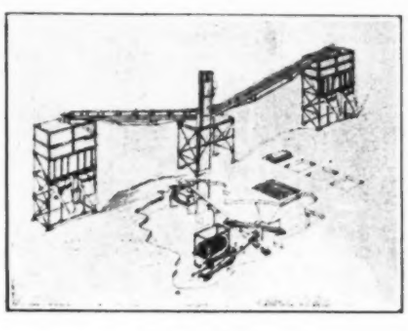

Fig. 6.

mechanical shake-out (located in the centre of the floor), from which sand is fed to an apron conveyor, which in turn discharges to a hexagonal tapered screen. After screening, the sand drops through to a cross-belt delivering to the tempering belt, while the refuse is ejected from the end of the screen into a box. From the tempering belt the sand proceeds to a sand conditioner and mixer, from which it is elevated to two distributing belts overhead, and thence delivered to the moulding-sand hoppers. These hoppers are equipped to deliver the sand directly to the moulds by means of movable hinged shutes.

There is no special sand used for facing the mould, the whole of the sand contained in the moulding box being of the same quality. The sand is allowed to pass into the moulding box covering the pattern, and is then jolt rammed, the

box turned over, and the pattern extracted by crane.

### Air-Brake Castings.

Fig. 7 shows part of the equipment used in the production of various castings required for air brakes. Twenty-three men make three hundred moulds in an eight-hour day. Power moulding machines are employed. A well-prepared strong sand is used, because the large cores shown in the illustration are made in green sand. The core bar is of cast iron, and perforated for venting. Trunnions are let in the open ends. To make the core, the barrel, which allows a layer of about ¾ in. of sand, is placed astride the sand hopper resting in bearings permanently fixed. After damping the barrel with molasses water the prepared sand is patted on to the barrel and strickled to shape by using the machined edges of the barrel.

A modified system of the one first explained again obtains. From the shake-out grate the sand is delivered by a belt first to an elevator from which it passes through a screen into a 50-ton storage bin. The bottom of the bin is equipped with a feeder delivering to a belt conveyor, which delivers to a second elevator. This in turn discharges on to a tempering belt, from which the sand is ploughed off into the moulding hoppers over the moulding machine.

Hoppers, with an opening at a convenient level, are also provided for the coremakers so that they can shovel or scoop the sand out by hand into the core machines. For conveying the moulds from the moulding machines to the pouring zone, thence through the cooling zone to the shake out a gravity roll-conveyor is used. The flasks are returned back behind the moulding machines by another gravity roll conveyor.

Fig. 8 shows one of the foundries of the Link Belt Company. In its main features it is similar to another foundry of the same company which the author visited in Chicago. The dark places in the centre of the floor are the shakeouts. Distributing belt conveyors are shown on each side of the foundry delivering sand to the moulding machines which are located along both walls.

### The Ford Plant.

The next photographs, Figs. 9, 10 and 11, show a scene witnessed in the foundry of the Ford Motor Company, Detroit. The Rouge plant of the Ford Company is six miles from the centre of Detroit, and is the largest of its kind in the world. The main melting plant consists of 38 cupolas, and the iron is distributed by mono-rail system. They have several times tried to use the hottest metal direct from the blast furnace, but without much success. It is understood that they may instal an electrically heated furnace for using and mixing direct blast-furnace metal.

Production castings are made on moulding machines, and the moulds carried on conveyor systems. There are two types of conveyor systems in use. One is the pendant conveyor type, as shown in Fig. 9. This illustration shows the general casting arrangement for pouring most of the smaller castings. It must be noted, as with all other arrangements, that the conveyor is moving whilst casting is proceeding. The cylinders are moulded on drag type conveyors, and casting is again done by ladle hand-pushed on a mono-rail at the same rate as the conveyor, on which the mould is moving.

Fig. 10 shows a sectional coring of a cylinder as it moves forward on a drag conveyor. One man locates one core to gauge, the next man another and so on until all the cores are located. Sand slingers are used both for making moulds and cores. The cores are dried in continuous ovens, the cores being supported from an overhead system as they travel through the oven.

There is a sand handling system for each moulding unit

They had developed a type of tumbling barrel of their own, and each barrel is driven by a motor. Fig. 11 shows a scene in the Ford Company's dressing shop. The tumbling barrels are fed by conveyors, which bring the rough castings to them and carry away the cleaned castings when tumbled.

The success secured in the Ford foundries is due to continuous operations, aided by moulding machines of various kinds, conveyors of various types, mono-rail systems, and the cutting up of the work necessary to the production of a casting, so that a large number of specialists contribute to the final product. In the production of one of the largest single cores for a cylinder as many as fifteen coremakers contributed to its production. All operations must be done to a set time, because everything is moving.

In addition the Ford Motor Company has two jobbing foundries, one with a capacity of 90 tons per day of grey iron, and which has three cupolas and one steel foundry, with one 50-ton and two 10-ton electric furnaces.

### Moulding Locomotive Cylinders.

At a locomotive works in Philadelphia the system of moulding cylinders was exceedingly efficient. Only a rough and general outline can be given. The cylinders, weighing between 30 and 40 cwts., were moulded in about twenty hours. Similar cylinders in Britain take three times as long to make. Briefly the practice was:—One half of the pattern is located by dowels on a machined cast-iron plate, which rests on a large pneumatic jolt ram machine. An open moulding box, with four collapsable sides, is placed around the pattern located by pins, which sit on the machined plate. Special sand, which has been prepared in a special mixing plant, is deposited in a large heap inside the foundry. The electric crane drops a grab bucket into the prepared sand pile and dumps the contents into the waiting moulding box and over the pattern. Whilst the crane with the grab bucket is returning for a second load, which is sufficient to fill and ram the half box, the moulder tucks the sand where necessary against the pattern. As stated the contents of the grab filled twice is sufficient to ram the moulding box to the surface.

No attempt is made to prepare a special facing sand. The whole of the sand composing the mould both top and bottom is of the same grade. The mixture of sand was of rather a rough nature, and made up of coarse gravel sand, which formed about 50 per cent. of the mix, a finer sand, named Jersey sand, heap or floor sand, coke-dust, fireclay and core gum.

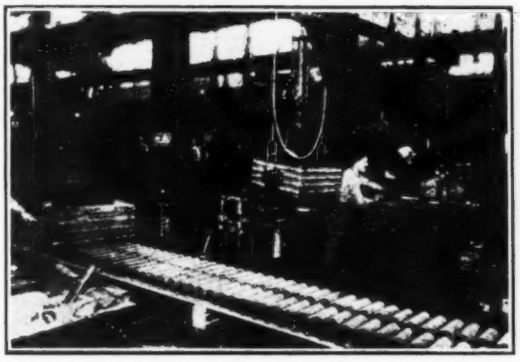

FIG. 7.

FIG 8.

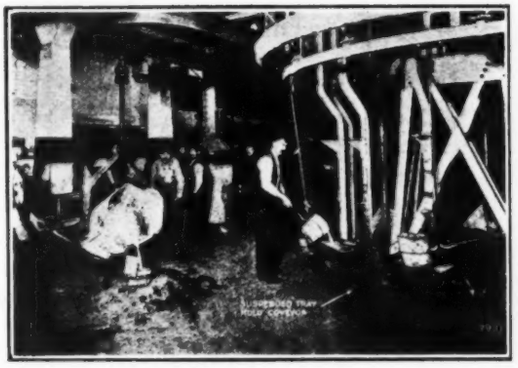

FIG. 9.

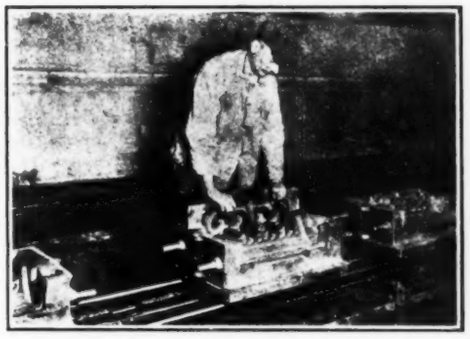

FIG. 10.

When the box had been jolt-rammed and the surface level with the top of the box had been strickled off, a bottom plate was secured to the drag. No venting appeared to have been done. The box, with bottom plate attached, is next turned over by a crane, and the pattern extracted. After finishing and black-washing the collapsible sides are removed, leaving the mould standing like a core. When the mould is dried it is very strong, due to the mixture described.

The top side of the mould is made in the same manner as the bottom half, except that the sand is contained in an ordinary barred moulding box to allow of turning over and placing on the bottom half of the mould. After drying the moulds, the cores are adjusted, and the whole lifted and located in a casting pit with cast-iron sides. Loose green sand is rammed around the small space formed by the sides of the pit and the sides of the mould up to the joint face. The top half box is located by lines struck on the joint faces of the top and bottom half boxes. In this foundry the cylinders were cleaned free from sand, etc., by hydraulic power.

### Coremaking.

In America there appears to be more extensive use made of artificial core sand binders, such as fire clay, flour, rosin, both liquid and powdered, and oil, than in this country. Oil is comparatively cheap in the States, and, as will be expected, is commonly used. The methods employed to convey sand to coremakers are by cart, electric or gasolene tip-trucks, belt conveyors, overhead-hand-push or man-riding mono-rail crane. In several foundries visited the core shop was situated on a second floor, and mixed sand is delivered by elevator from the first floor on to a conveyor belt, from which it is ploughed into bins above the coremakers' benches. From the bins are led shutes, from which the coremaker releases sand when and as required.

Types of coremaking machines used are sand slingers, power jar ram and hand ram, using multiple core boxes. In several foundries a new type of machine was used, namely a core blowing machine. As this type of machine is little known in Britain a detailed description is necessary.

Fig. 12 shows a Swedish core-blowing machine. A boy operator is seen standing by the machine and in the act of blowing oil-sand into a core box. The machine consists of a sand container with a glass window and bellows. The apparatus sits on a table or bench. A valve is opened and shut alternatively by a conveniently located handle, and the compressed air from the air pipe is either admitted or shut out. This has the effect of impelling the sand through the mouth-piece and along a rubber tube into the core box. The valve is adjustable to various strengths of air pressure for different cores. The machine works at an air pressure of 11 to 13 lbs. per sq. in.

If the core needs an iron to strengthen same the material is simply placed in the empty box in the region where required. The force of the incoming sand seems to lift and surround the core iron. The core boxes which are preferably made of metal have channels cut to allow escape of air at the moment when the sand enters the box. An extraordinary rate of production is possible, and the machine is of thoroughly practical use for both simple and fairly intricate cores. Fig. 13 shows a number of cores made on such a machine.

### Core Ovens.

Core drying ovens are of various types, the continuous oven of the carrier rack type similar to those described in the Ford foundries is not uncommon. Cores placed in the stoves at one point pass on through the stove and are dried whilst on the move. When they pass out they are blacked, cleaned, vented and parts pasted and assembled, and then on to the moulders or some place allocated as a store adjacent to the mould-closing section.

For the continuous system of drying oil and gas are used as fuel. A uniform temperature is obtained and maintained at all times. Drying by electricity and steam pipes is also practised by several companies. Hard fuel is in common use, but it is burnt in most cases in economical systems of combustion and circulation. One such system was noted whereby ten medium-sized stoves were efficiently fed with heated gases by one fire box. Wherever possible core departments are centrally disposed in the foundries, and cores are made a full day in advance of requirements.

### Dressing of Castings.

The following will outline the various operations and equipment used to fettle and clean castings. As noted in the States, several types of conveyors are used to carry castings to dressing department. In some cases after moulds have been shaken out the castings are pushed down shutes and fall on to a conveyor which continues to the cleaning department. Others are delivered by overhead bin carriers. Or it can be seen where a continuous apron conveyor runs the full length and down the centre of the foundry on which the castings ride alone, or in company with the sand knocked from the moulding box. At a certain point the castings are forked off and diverted to the dressing shop, and the sand proceeds to the tempering and mixing plant. In one foundry visited the castings were deposited by the apron conveyor into a chamber, the floor of which was composed of reciprocating bars set about ½ in. apart. The loose sand deposited along with the casting dropped between the moving bars and on to a belt conveyor and from thence to the mixing department. The rising and forward movement of the bars jolted the castings at the same time as they were impelled forward to the stationary floor of the dressing department. It will be realised that further sand was shaken from the casting, both from the outside and from the cored interior, and also the action was sufficient to break away fin and small runners and risers before the castings came to rest.

Ordinary drag type conveyors are used by many foundries similar to the one shown in Fig. 10. Man-riding mono-rails are employed to collect and deliver castings from department to department. Electric trucks are also commonly used for conveyance of castings. Sometimes castings are deposited immediately in specially constructed tumbling barrels, which are carried by two arms on an electric truck from foundry to fettling shop. After filling, the tumbling barrel is deposited into its appointed place in the tumbling machine. Electric crane trucks with magnet are also occasionally employed to lift and carry castings.

In a large foundry specialising on locomotive castings, cleaning of the cylinder which weighed about 35 cwts. was achieved by hydraulic power. The casting is placed in a metal chamber resting on a table which revolves, and strong jets of water at about 300 lbs. pressure wash and search out all cores and sand adhering to the outside of the casting. Bricks and even portions of core-iron were to be seen lifted and deposited on the floor of the hydraulic room. About 12 to 15 minutes was taken thoroughly to clean such a complicated casting of everything except strong flash and runner and riser gates. In the ordinary way such a casting would take nearly a day to clean by one man.

Sand blasting and tumbling barrels and emery grinding were ordinary features; but the author is of the opinion, after visiting many foundries in Britain, that the Americans employ more extensively such electrical and pneumatic appliances as portable swing grinders and chipping hammers. Oxy-acetylene plant is extensively used for cutting gits from both steel and non-ferrous castings, whilst oxy-acetylene and electric welding of defective castings is common. Nothing is scrapped which can be salvaged. Foundry and machine shop wasters together averaged from 6 per cent. in day-rated foundries and 6 to 12 per cent. in piece work shops.

Many ingenious devices and gadgets were used in addition to those described, of which there are many variations, and which have been adapted to suit the layout of the plant.

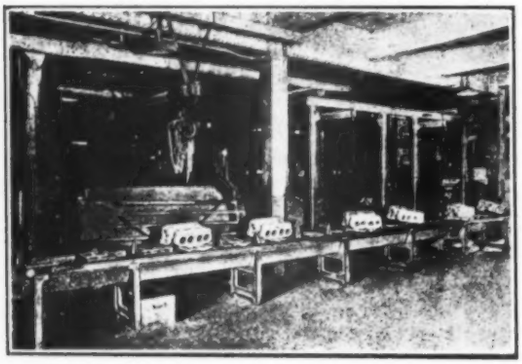

Fig. 11.

Fig. 12.

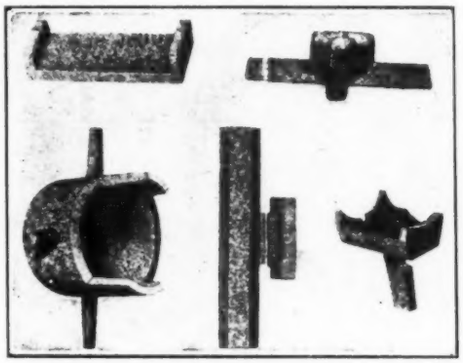

Fig. 13.

### Cupola Charging and Distribution of Metal.

The delivery of materials to cupola stage and charging was carefully noted. At the majority of the foundries visited one saw either some form of mechanical charging of the cupola or special arrangements for delivering materials to the feeding platform. Whilst it is not wished generally to detract from the economy of mechanical charging if the metal to be melted is substantial the author was rather surprised to find that at one large foundry the cost of melting was not as low as one would expect. Other foundries showed better results.

In the foundry referred to they fed 2,000 lbs. of iron, plus 11 per cent. of fuel, per charge. The material was located in deep bins situated in the stock yard. Pig-iron and scrap was lifted by an electromagnet, operated from a travelling crane which spanned the yard area. From the magnet the metal was released into charging buckets with collapsible bottoms. The buckets were then lifted by a charging device attached to a man-riding mono-rail crane. The bucket was then run direct into the cupola feeding door and the charge deposited by opening the bottom doors of the bucket. Coke and limestone were not handled in any way indirectly by the magnet. This part of the charge was dealt with by the telpher charging machine.

The men engaged about the cupola were:—Four in the stock yard, one yard-crane driver, one for the telpher charging-machine, one tapping metal and one slagging and tuyere cleaning and one general, making a total of nine. The melt per day was 100 tons, and they received a tonnage bonus which usually lifted the wages to time and one half. On day-rate this would approximate or be equal to the employment of thirteen men, giving about 7¾ tons melted per man per day ordinary rate.

At a large foundry with which the author was connected several years ago, it averaged 6 tons per man on the same basis as above, but charging by hand. As the wages received by our men is about 38 per cent. that of the U.S.A. cupola men, the cost of such work is decidedly cheaper in Britain where hand charging is almost the rule. But there is no doubt that the men engaged about the cupola do not labour quite so hard with mechanical charging. This is certainly a good feature.

It is a little surprising that the battery of 38 cupolas situated in the Ford foundry at Detroit is not mechanically charged, although by special mechanical arrangements material is delivered expeditiously to the charging platform where it is hand-fed to the cupola.

The cupolas of the Ford repetition foundry are arranged along one end of the department, and the slag spouts are all connected up with a common tunnel. The slag is driven and washed down

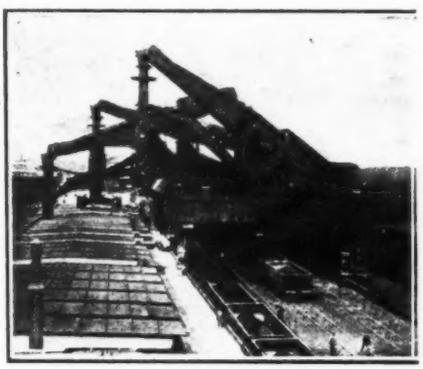

Fig. 14.

this tunnel by a strong stream of water. The great majority of foundries had various modifications of the mechanical charging described. The only system of mechanical charging which thoroughly satisfied the author was practised at a large foundry in Chicago, where they used electric industrial trucks. The trucks performed three distinct operations. Special charging buckets with collapsible bottoms are picked up by two arms attached to the truck. These arms or forks are adjustable, and can be operated up and down as required. Before leaving the stock yard the material in the bucket is weighed by scales, which form part of the truck. The scales can be disengaged after weighing the material. The truck, with its load, moves on to the hoist, thence to the stage and the cupola mouth, where the contents of the bucket are discharged. The arms of the truck which carry the bucket protrude into the large charging opening in the cupola. The material is discharged by a manipulation of the arms, which when hoisted, engage a trip lever, causing the bottom doors to fall and deposit the material in the cupola. The spread of the charge was very satisfactory.

At another foundry the charging buckets were operated from specially constructed electric truck cranes. In this case weighing of the material was effected before picking up by the charging truck.

In several foundries the electro magnet was used to operate the drop ball for breaking scrap. The efficiency was very marked because in the ordinary way when using a snatch block much time is lost in arranging the ball into position. Much use is made of the teapot pouring ladles. Metal is commonly distributed about the foundries by either hand-push or man-riding mono-rail systems. In one of the foundries the amount of metal in each ladle on the mono-rail is weighed, and they have designating numbers which indicate where each ladle is to go, so that there is order in distribution of metal.

Nowhere did the author see in operation any contrivance or mechanical aid for tapping or botting the metal. But much use is made of the tee-head spout for continuous pouring.

Fig. 14 shows a scene similar to one we saw on the shore of one of the great lakes at Cleveland. The picture shows a group of automatic ore unloaders. Seven of these machines have discharged 11,000 to 12,000 tons of ore in under three hours. Only three men are required to operate one machine. Each machine accurately weighs the ore.

### Quality of Metals Used.

As is well known, American grey irons are of a soft texture generally, and not so strong as iron in Britain. There is a widespread use made of steel scrap to improve and strengthen grey iron. In one foundry they introduced 95 per cent. of steel along with an alloy into the cupola to produce a special white cast iron for use in rollers subjected to heavy abrasive action.

At a previous lecture reference was made to the practice of another foundry in the States. They introduce two grades of iron into machine-tool castings. An improved cast iron, by introducing 25 to 40 per cent. scrap steel into the cupola, was poured into the wearing surfaces of the castings, which are arranged face down in the mould. After the semi-steel has been poured into the mould at one end, the remainder of the mould is filled by a very ordinary grade of metal through a second set of runners at the other end.

Several foundries use cast-iron borings briquetted by powerful presses which gave strong, tough blocks about 3 ins. by 4 ins. dia. These blocks can be charged like scrap and pig-iron. Great care is exercised to ensure that borings from different grades of metal are collected and stored separately.

At a foundry in Buffalo steel borings were also briquetted along with cast-iron borings. In isolated cases steel borings and turnings are briquetted for use in grey-iron mixtures for unimportant castings like sash-weights, etc. Considerable use appeared to be made of nickel in grey-iron mixtures, and many apparently exaggerated claims were made as to its beneficial effects on the properties of the iron. It is estimated that one-third of American grey-iron foundries introduce nickel or nickel-alloys in one way or another into grey iron. They have discovered how to produce an excellent pearlitic cast iron. It is named Meehenite. Professor Touceda gave the visitors full particulars. An alloy is added to metal in ladle to precipitate carbon, otherwise the metal would be a white iron.

Electric furnaces are commonly used for melting steel, whilst for malleable iron extensive use is made of air furnaces. But in one foundry they have discontinued the use of air furnaces and substituted duplexing with cupolas and electric furnaces. In the pattern shops very considerable use is again made of machinery. Electric drilling and screw driving was quite common. Generally speaking, conditions in the foundries visited could be said to be very healthy, and great consideration is paid to the comfort of the foundry operatives.

In a foundry of the Westinghouse Company, at Philadelphia, the author was surprised to see a shop located inside and at one end of the department. Workmen were permitted to purchase refreshments during working hours. Tobacco, sweets, cakes, and soft drinks, etc., were arranged in as orderly a manner as in an outside shop. Such facilities are not uncommon.

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**Leipzig Spring Fair, 1928.**—The United Japanese Chambers of Commerce have decided to promote a large exhibit at the forthcoming Leipzig Spring Fair, which is to commence on March 4, 1928. The amount of space already definitely booked is 1,800 sq. ft. The Yugoslav Finance Minister also has authorised the Minister of Commerce to spend a considerable sum in connection with an official exhibit at the same Fair.

## Random Shots.

It is a point that is open to debate whether the last week of the year is a time of gloom or a time of joy—gloom at the thought of the good intentions with which one more twelve-month is now paved, joy at the prospect of a fresh start with a full cargo of Resolutions, nicely tied up and labelled ready to drop overboard the moment it seems necessary to lighten the load. Were it not for the too recent shadow of Christmas, one would be tempted to feel that the prospect of a fresh orgy of virtuous resolution would overwhelm any faint regrets at the tragedy of broken resolves a full year old; but, unfortunately, the week before New Year does happen to be the week after Christmas as well. . . .

* * *

And how can mortal man be expected to be cheerful the week after Christmas? Think for a moment of the bills to be paid. Think of those ties, the result of heaven knows what skilful advertising on the part of an overstocked hosier in Aunt Angelina's home town. Think of—or rather, listen to—the sweet strains of the toy trumpets distributed to the family by a bachelor uncle with an innocent mind. Think of the semi-somnolent condition, over-fed and under-exercised, of everyone with whom you come in contact, almost certainly not excluding yourself. . . . Well, it would surely take a mint of New Year Resolutions, including quite a few on the part of other people, to overcome such potent causes of gloom. . . .

* * *

Of course, the real difficulty is that New Year Resolutions are not tackled in the right way. We make them for ourselves, that we may have the luxury of breaking them, whereas we ought to make them for other people that we might have the luxury of seeing them kept. It should, for instance, be possible to arrange that a resolution signed by a minimum of one hundred persons should have the binding force of law if formally served upon the recipient on the first day of the year . . . what a weapon for the public good lies here!

* * *

Here at last, for instance, would be a means of defence against the Chancellor of the Exchequer—or that lesser luminary the town council. It would be so easy to find a hundred people willing to sign a resolution to the effect that the Income Tax be reduced to half its present rate. . . . Indeed, there is no public enemy who could not be thus assailed.

* * *

The weak spot in this otherwise excellent scheme is that the resolver in one case might so easily be the resolvee in another. And what then? We can contemplate with equanimity the besieging of other persons on New Year's Day with resolutions in restraint of their actions and avocations; it would be a good deal less pleasant to be assailed with them ourselves. . . . That is the worst of these brilliant inventions; they are a little too apt to emulate the boomerang, and recoil upon the inventor, in the manner of the mechanical woman in the much discussed "Robot" film, "Metropolis."

* * *

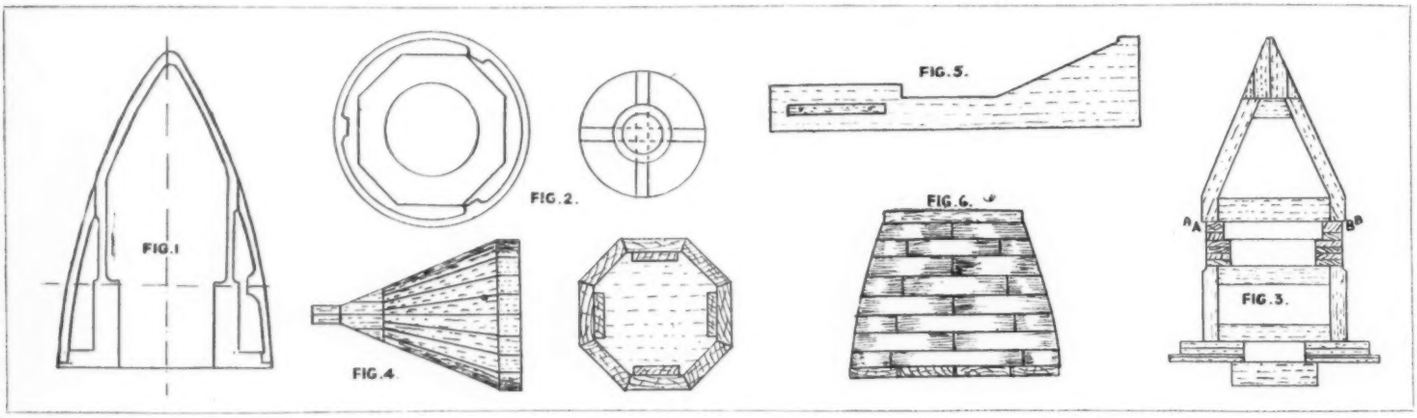
At the recent dinner of the London Branch of the I.B.F., to which I have already referred in this column, the state of trade not unnaturally came in for its share of attention. The necessity for a cautious adjustment to a new industrial equilibrium without violent fluctuations reminded me, irresistibly, of the old lady on the fog-bound river steamer. She plaintively asked the Captain when they were going to move on, and hearing that the fog was too dense objected that she could after all see the stars overhead quite plainly. "Yes, Ma'am, I dessay you can," the Skipper replied, "but we ain't a-goin' that way just yet, not unless the boilers bust!"

Marksman.

# Propeller Cone Caps.

By Ben Shaw and James Edgar.

Propeller cone caps belong to that class of casting, which, though apparently simple, present difficulties to the inexperienced. In marine shops, there is generally a stock of standard patterns and strickles for caps which can be modified to suit particular jobs, but occasionally new patterns have to be made. Caps are often made entirely with strickles, but much depends naturally on the design and the size. It is proposed to discuss here the patternmaking and moulding of a representative cone cap.




The propeller cone cap, shown in Figs. 1 and 2, consists of two castings, the cone nut proper and the outer sleeve. This outer sleeve goes over the nut and completes the cap after the nut has been screwed on the propeller shaft. With regard to machining, the usual allowances will be sufficient. While a skeleton pattern could be made, it is doubtful if any real advantage would be obtained. It is usual to cast propeller cone caps point down when of bronze and the reverse way when of iron. In making the pattern it is necessary to make a joint because of the smaller diameter between the nut and the cone, and the most convenient place to do so is at the line AB, Fig. 3. The two parts of the pattern are connected by a circular dowel which is screwed on the cone end and fits into a turned recess on the other part. This is a much better method of joining the two parts of the pattern than using small dowel pins, which are easily broken. Fig. 3 explains fairly clearly the actual construction of the pattern as a whole.

The best construction for the conical end is shown at Fig. 4. The staves can be conveniently planed on a planing machine to the correct angle, so that very little hand finishing will be necessary. Attention may be drawn to the deep print on the flange end of the cone cap which should be about 3 ins. thick, especially if the core is going to be hung.

For the core of the nut which may be made either on a vertical or horizontal spindle a strickle is necessary, Fig. 5 shows a suitable strickle for a horizontal spindle. It must be left about 12 ins. longer than the core at each end. A diameter gauge may be fastened at one end but at the apex of the core the strickle will bear on the spindle. It is obvious that the core cannot be strickled to the apex, but the core maker can make up the end when he finishes the core.

A view of the sleeve pattern is shown at Fig. 6, no jointing being necessary. There is no print on the large end. The sleeve would be moulded with the smaller diameter down, and a top print would invite disaster through crushing when the mould is being closed. The core for the sleeve should be made on a vertical spindle, and the strickle necessary will be of two pieces of timber half-lapped at right angles, a diameter stick being supplied to the moulder. What is called in pattern shops, occasionally, a pin board, may be made for the core. Instead of leaving the core maker to set the strickle, a bottom plate is supplied with a circular pin half-lapped into the top board of the strickle, and a hole bored into the plate to fit the centre pin. The only advantage of this method for a plain core, in the writers' opinion, is that the strickle is set and checked before it leaves the pattern shop.

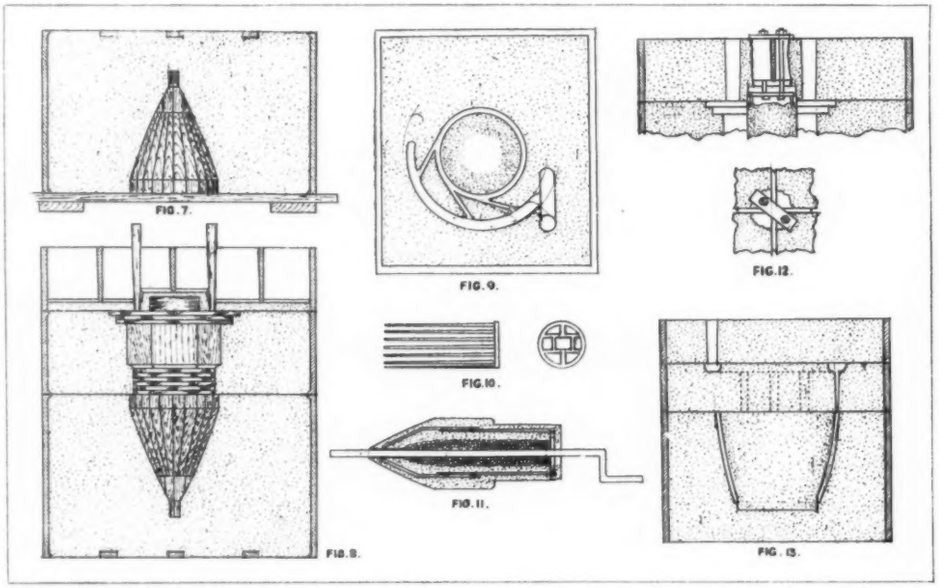
Although it is true that these castings are sometimes made in cast iron they are more generally of bronze. The procedure adopted in the production of suitable moulds would be somewhat similar but some modification in running such jobs would be advisable for iron casting. In this article we are dealing more particularly with bronze castings, with only an occasional reference to modifications suitable for cast iron.

Patterns are frequently despatched to foundries that are jointed longitudinally, which necessitates the preparation of the mould in a horizontal direction, but arrangements are made for casting on end. There is considerable risk when this method is forced upon the foundry, because the mould needs to be closed before turning it on end and some movement of the core is likely. Thus, although a two-part box would be used, in such a method, it is better to prepare the pattern for moulding in the direction it is to be cast.

For this method a three-part box is involved. The drag is preferably prepared by the turn-over process, as indicated in Fig. 7, and the facing sand should be well rammed against the pattern. Rolling over the drag and proceeding with the middle part is a comparatively simple operation, but, since it is rarely that special boxes are made for such a job, it may be necessary to sink a joint about the top flange to clear flat bars in the cope. The middle box part is preferable that carries short bars about the sides, but failing that rodding is generally necessary, even though the part is fairly deep. A substantial runner stick should be located in one corner of the first joint.

Chills are profitably used about the vent, even though substantial risers are located about the top, and these need to be inserted during the process of ramming. The formation of the mould is shown clearly in Fig. 8. In stripping it is just as well to withdraw the nut section of the pattern after lifting the cope when the middle part can be removed. Before extracting the conical end it is better to make up the runners. The tangential spray indicated in Fig. 9 is a very suitable form of runner for a job of this kind, and it is more effectively employed in conjunction with a large runner basin. These sprays need to be carefully formed, sand corners being removed and brads liberally employed.

This method is not so suitable for an iron casting since iron is more fluid and will free itself better by pouring direct into the top and following the largest diameter of the core. Keeping the top surface in a turbulent condition largely prevents



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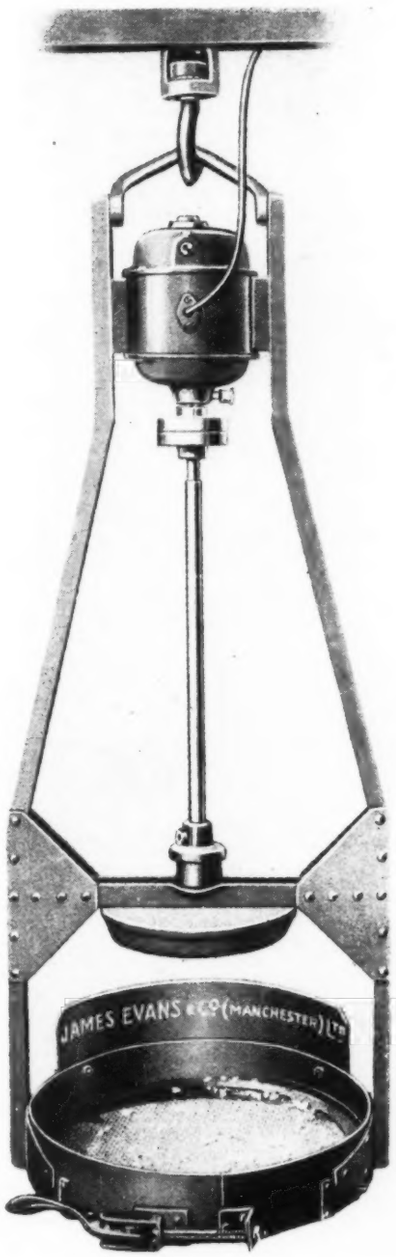
# GYRATORY FOUNDRY RIDDLE




THE saving accomplished by the use of our Electric Gyratory Riddle pays for the cost of the machine in a few weeks' time.

It will sift more sand with one operator than six men sifting by hand. In addition to this it mixes the sand better, and produces a better grade than hand labour.

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dross adhering to the mould sides. On the other hand, maintaining the surface of bronze in a turbulent state is likely to increase oxidation and cause much of it to become permanently suspended in the metal with a resultant weakening effect. Much care must be exercised in the making of the core. It is usually swept on a spindle, and the board should sweep a good square shoulder at the print end. A grid is practically essential, and long gaggers should be cast on.

Fig. 10 shows a form of grid suitable, and it will be noted that it is located in the core (Fig. 11), with the grid near the print end: some prefer to arrange the grid at the bottom of the conical shape carrying the gaggers towards the print end and casting-in pieces of wrought iron to support the cone shape. With this latter method long staples are necessary for lifting and also for hanging to the cope, and they must be easy of access. The form of grid indicated is just as convenient, and is more considerable. Straw-rope should be wound round the spindle with a thin covering of hemp or hay near the apex of the cone before any core loam is applied, when the grid can be slipped into position. It should be temporarily wedged to the spindle, and a piece of wrought iron can be wired to the gaggers as shown and bedded in the loam. The loam should be allowed to stiffen before completing the sweeping of the core, and, when completed, it should remain on the spindle until thoroughly dry when the spindle can be withdrawn.

It is necessary to remove the charred hemp or hay from the apex end, damp the loam about the hole and plug it with core loam rounding the core to the required shape. Both core and mould, after being dried, need a facing wash, and when thoroughly dried are ready for assembly.

It is suspending the core that creates a difficulty. To attempt to locate the core in the cope in an inverted position, to fix it and then turn it over is asking for trouble; even if this is successfully accomplished there is no guide for lowering it into the mould with the assurance that the required metal thickness is preserved. A good plan is to fix a number of nails or chaplets about the mould of the conical shape, and just sufficient to support the weight of the core. They should be set to register the required thickness of metal, and the core lowered in. When it is supported, the height of print can be checked, as also can its position in the centre of the mould.

In order to obtain a safe registering of the cope on the core print it is advisable to cut the sand away through the cope and within the compass of the print, as shown in Fig. 12. Generally this is arranged for during the time of ramming the cover. By this means the core can be sighted when lowering, and its successful registration practically assured. Once it has been properly closed hook bolts can be used to secure the core to the cope and the sand made up with ashes to ensure a ready vent from the core. Riser bushes and a runner can be placed, the job weighted and made ready for casting.

The plain cylindrical casting required for the sleeve needs little explanation; the illustration, Fig. 13, will indicate the type of mould suitable. These sleeves are invariably cast with a head on of about two inches. The concealed runner supplying a number of sprays similar to that frequently used for straight bushes is profitably employed in this case.

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**A Safety First Stunt.**—An American firm has thought out yet a new idea for drawing attention to accident prevention. At the entrance to the works they installed a board covered by a curtain which bore the notice, "The only man who can prevent you from getting hurt is behind this curtain." Upon raising the curtain the workman sees a reflection of himself in a mirror.

**Refractories in the United States.**—Bulletin No. 266, published by the American Bureau of Mines, copies of which ore obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C., at the price of 40 cents, is devoted to silica and sand, and is thus naturally of interest to founders. It contains 204 pages. A second publication has been made on this subject by the American Refractories Association, but in this case fireclay is the main theme. It costs 50 cents and obtainable from the American Refractories' Institute, 2202, Oliver Building, Pittsburgh, Pa.

# The Theory of Superheating Cast Iron.

By Our Metallurgical Correspondent.

The notes on the theory of superheating cast iron, of which an abstract appeared in The Foundry Trade Journal of August 4, appeared to have suffered somewhat in their drastic abridgement from the original notes by Hannemann, which were published in "Stahl-und-Eisen," No. 17, pages 693/5, 1927. The experimental results of Piwowarsky, in particular, with which this theoretical treatment is concerned, are of a somewhat unexpected nature, and, as indicated in the final paragraph of the notes, still remain to be confirmed. In addition to this the writer is of the opinion that the theoretical considerations of Hannemann are deserving of criticism from several aspects.

The experimental results obtained by Piwowarsky, referred to above, have appeared in a fairly full abstract in The Foundry Trade Journal of October 15, 1925. In his investigations Piwowarsky observed the influence of an increase in casting temperature, or more strictly the initial temperature from which cooling commenced, on the mode of existence of the carbon contents in the final material. A most important feature in these experiments is the fact that the rate of cooling was maintained at a constant

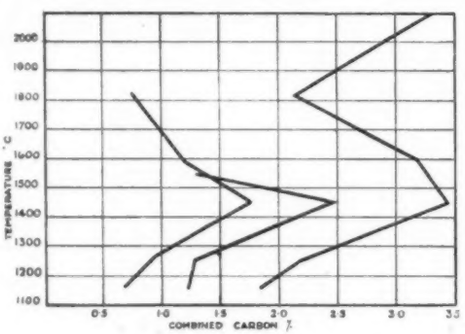


Fig. 1.—Piwowarsky's Curve.

value. During the experiments "the melts were heated up to the stated temperature and cooled at exactly 3 deg. per min. (regulation by current choking) then, about 20 to 30 deg. below the eutectic critical point, dipped with the crucible in water and quenched." It is not without significance that in two of the series of tests the cooling was conducted in an atmosphere of nitrogen. The results of these investigations are exemplified by the curves given in Fig. 1, which graphically illustrate the change in combined carbon contents with the increasing temperature of the starting point of the cooling. In a similar manner Piwowarsky obtained evidence of the effect of both silicon content and prolonged heating on the character of these curves. It is very interesting and important to note that the inflexion in the curve as illustrated in Fig 1, was maintained in all cases. Piwowarsky concludes that "there evidently exists in all pig-iron or cast iron a definite critical temperature range on exceeding which the molten iron acquires an increasing tendency to solidify grey."

The difficulty of explaining this phenomenon is fully realised by Piwowarsky himself. He considers that the results point to a condition in which the carbon can exist in the liquid iron in two conditions, which it is quite natural to assume are the carbide of iron condition and the graphite condition. Whilst his explanation of the inflexion of the curves, based as it is on an assumption of a zero value in the heat of formation of $Fe_3C$ at the critical temperature is not very convincing, and calls for equally as much explanation as the inflexion itself, his confirmatory experiments are even more interesting than the original experiments.

In these confirmatory experiments he was able to show that by maintaining a sample at the critical temperature for a short and a long period respectively, the tendency to the carbide condition increased considerably in the sample held for the longer period.

It is difficult to ascertain from the article by Hannemann above referred to exactly what his (Hannemann's) explanation of these phenomena really is. It would appear that Hannemann is endeavouring to show that since the combined-carbon results of Piwowarsky lie below the equilibrium curve for the particular composition that this indicates that solidification of these alloys has taken place in accordance with the requirements of the stable iron-graphite system, and that for this reason there is no need to assume the existence of two forms of carbon in solution in the liquid iron.

The alloys considered by Hannemann are eutectic alloys and it is hardly possible to contemplate such alloys as "molten at a temperature below the liquidus line." The further assumption that "the melt contains also undissolved graphite" and that "the graphite is rejected in the finely-divided eutectic form" must also be classified as errors in argument.

The accuracy of the position of the line E, E$_N$ in Hanneman's diagram, Fig. 3, is a matter of considerable doubt, and it is doubtful whether this does represent the true equilibrium conditions. The position of this line and also the slope of the line A K, are very different when constructed on the basis of later English work. The diagram given in Fig. 2 is the reproduction of Hanneman's Fig. 3, on which the writer has superimposed curves of the same indications based on more recent British work. The superimposed curves are drawn for a temperature condition of 20 deg. below the eutectic line corresponding to the quenching temperatures adopted by Piwowarsky. The conditions of temperature indicated by the lines drawn by Hanneman are not stated in the

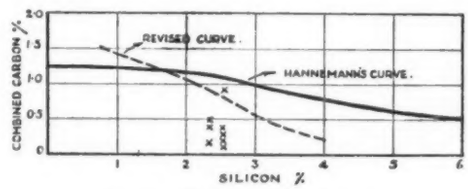


Fig. 2.—Hannemann's Curve.

article referred to. The position of the line, as re-drawn, places at least one of the results of Piwowarsky above the line, indicating, according to Hanneman, that solidification in this case has taken place in accordance with the iron-iron carbide system. Furthermore, the whole of Piwowarsky's results are not plotted on the diagram, Fig. 3, of Hanneman, and if this is done, as in Fig. 3, in this note many of the values are found to lie above the curve as indicated. This fact would appear to dispose of Hanneman's alternative contention.

The rate of cooling in all Piwowarsky's experiments was definitely controlled, and would be expected to be uniform; in one case a uniform rate of cooling of 3 deg. per min., in another case 50 to 60 deg. per min. It can be said at once that the results would not have been difficult to understand if the cooling had taken place under freely cooling conditions. For this reason one cannot help but question the accuracy of the control of the rate of cooling in the experiments. In several of the experiments the uniform cooling was stopped very close to the eutectic temperature, about 20 to 30 deg. below the eutectic temperature in one case, and at 1,050 deg. C., about 100 deg. C. below the eutectic temperature in another case, at which temperatures the samples were quenched out in water.

It is generally accepted that the commencement of graphitisation takes place at a temperature very close to the eutectic temperature but below it. The quenching of the samples at a temperature close to the eutectic temperature without reference to the commencement of graphitisation leaves us with insufficient facts with which to consider the possibility of any influence within this region. In any confirmatory experiments it is highly desirable that they should be conducted under freely cooling conditions down to temperatures at least below the pearlite point.

## ALUMINIUM ALLOYS
### B.E.S.A. Standards

(Part of) Aluminium Data Sheet A 121

| Specification. No. | Specified Chemical Composition.[1] | Description. | Minimum Tensile Properties.[2] Ultimate tens. str. Tons sq. in. | Per cent. elongation in 2 in. |
|---|---|---|---|---|
| 3L11 | *Copper* 6% to 8% ... *Tin* may be used up to 1% | Casting alloy | 9 | 5 |
| 2L8 | *Copper* 11% to 13% ... | Casting alloy | 9 | Nil |
| 2L5 | *Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ... | Casting alloy | 11 | 3 |
| L24 | *Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7% | "Y" alloy castings | 11 | Nil |

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .564 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width ½ in. to 1½ in., and parallel length 2½ in.

F.T.J. 18/6/27.

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| | | |
|---|---|---|
| ASH | not exceeding | 8% |
| SULPHUR | ,, ,, | 0·8% |
| VOLATILE | ,, ,, | 1 % |
| MOISTURE | under | 1·50% |

## Trade Talk.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND celebrated its jubilee recently with a dinner at the Hotel Great Central, Marylebone, the president, Mr. Arthur Smithells, being in the chair.

IT IS REPORTED that there is a likelihood of Sir W. G. Armstrong, Whitworth & Company, Limited, developing their shipbuilding business by commencing shipbuilding in another district on Tyneside. The firm have no statement to make on the report.

AT A MEETING OF the South Wales local branch of the Institution of Mechanical Engineers at Swansea, Mr. C. G. T. Billington (Cardiff) presiding, a paper prepared by Messrs. J. Adamson and F. Jones (of Joseph Adamson & Company, Hyde, was read by Mr Adamson on "Reduction of Steelworks Cost by means of Waste Heat Boilers."

MR. M. B. U. DEWAR, recently managing director of the Metropolitan Carriage, Wagon & Finance Company, Limited, and a member of the Industrial Management Board of Vickers, Limited, has, with the Timken Roller Bearing Company, Canton, Ohio, U.S.A., acquired from Vickers, Limited, the whole of the capital stock of British Timken, Limited. Mr. Dewar will be the manager of the British concern. The Ward End Works of British Timken, Limited, at Birmingham, are being enlarged and new plant installed.

SIR HENRY FOWLER, the president, presided at the annual meeting of the Institution of Mechanical Engineers at the Connaught Rooms. Those present, in addition to the Duke of York, were:—The Right Hon. Neville Chamberlain, M.P., Lord Riddell, Sir Robert Hadfield, Sir Henry P. Maybury, Major-General Sir Granville Ryrie (High Commissioner of Australia), Engineer Vice-Admiral Sir Robert B. Dixon, Sir John A. F. Aspinall, Sir Josiah Stamp, Sir Richard T. Glazebrook, Sir Vincent L. Raven, Sir Christopher Musgrave, Air Vice-Marshal Sir John F. A. Higgins, Sir Herbert J. Creedy, Brig.-General Sir William Horwood, Mr. Douglas Vickers, Canon Carnegie, Rear-Admiral B. V. Brooke (Comptroller to the Duke of York), Sir Alexander Gibb, Mr. Richard Allen, Mr. William Reavell, and Lieut.-Colonel Cortez Leigh.

THE SIGNATORIES OF THE employers' invitation to the representatives of labour to discuss industrial problems, are as follow:—Sir Alfred Mond, M.P. (Imperial Chemical Industries), Lord Aberconway (Tredegar Company), Lord Ashfield (Underground Electric Railways of London), Sir Herbert Austin (Austin Motor Company), Mr. Bernhard Baron (Carreras), Mr. Henry Bond (Richard Thomas & Company), Lord Colwyn (Lancashire and Yorkshire Bank), Mr. S. Courtauld (Courtaulds, Limited), Mr. David Davies, M.P. (Ocean Coal and Wilsons), Sir Arthur Dorman (Dorman, Long & Company), Sir Robert Hadfield (Hadfields, Limited), Sir Hugo Hirst (General Electric Company), Dr. A. E. Humphries, Mr. Kenneth Lee, Marquess of Londonderry (Londonderry Collieries), Sir Edward Manville (Daimler Company), Mr. M. Mannaberg (Bolckow, Vaughan & Company), Sir David Milne-Watson, Sir Frederick Mills (Ebbw Vale Company), Sir W. Peter Rylands (Rylands Brothers), Sir Josiah Stamp, Mr. W. Gilbert C. Vyle (W. and T. Avery), Lord Weir (G. and J. Weir, Limited), and the Hon. F. Vernon Willey (Francis Willey & Company).

## Gazette.

MR. R. CATTLIN, trading as R. Cattlin & Son, 55, Canterbury Road, Brixton, iron and steel merchant, has been adjudicated a bankrupt.

MR. F. W. BROWN, carrying on business at Stand Works, Hollis Croft, Sheffield, steel manufacturer, is paying a first and final dividend of 2s. 0½d. in the £.

IN THE DEBENTURE-HOLDER'S action of Atkinson v. the Stella Gill Coke & By-Products Company, of Newcastle-on-Tyne, Mr. Justice Tomlin has appointed a receiver and manager of the defendant company.

MESSRS. R. J. GRUNDY AND T. G. STODDART, brass founders and general engineers, North Road, Barrow-in-Furness, trading under the style of Grundy and Stoddart, have dissolved partnership. The business will be carried on in the future by Mr. R. J. Grundy.

MR. F. G. MARTIN, trading as Stedman, Crowther & Company, metal merchants and agents, who appeared at the London Bankruptcy Court on December 6 for public examination, had filed accounts showing total liabilities £72,874, of which £54,599 is unsecured, and assets expected to produce £42,622. The Assistant Receiver, asking for an adjournment, said that whereas the deficiency shown in the statement of affairs was only £11,000, an amended statement would show that the amount was really £50,000.

## Contracts Open.

**Ballsbridge, Co. Dublin,** December 31.—1,614 lin. yds. of 4-in. cast-iron T. and B. and C. water mains, 14 4-in. sluice valves and boxes, 12 fire hydrants and boxes, and 70 4-in. bends, for the Urban District Council. The Surveyor, Town Hall, Ballsbridge, Co. Dublin.

**Ilfracombe,** January 3.—A weighbridge, for the Urban District Council. The Engineer and Surveyor's Office, Ilfracombe.

**London, E.C.1,** January 3.—(1927—62/39) 72 cast-iron well segments in accordance, for the Metropolitan Water Board. The Chief Engineer, the Offices of the Board (Room 156), 173, Rosebery Avenue, E.C.1.

**London, S.E.1,** January 3-10.—(1) 66 sluice gates, 60 ft. by 18½ ft.; (2) 660 pairs of "Millers'" chilled cast-iron wheels with axles, for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.) Tenders due January 3 for (1) and January 10 for (2).

**London, W.2,** January 10.—(2) Helical and volute springs; (3) tyres and rolled steel wheel centres; (4) steel axles and forgings; (5) iron plates and bars; (6) steel plates and sheets; (7) steel bars and blooms; (8) steel castings (wheel centres); (9) ditto (miscellaneous); (11) chain and iron for chain manufacture; (12) tubes and fittings; (13) cold drawn steel tubes; (14) cast-iron socket, etc., pipes and iron castings; and (15) galvanised sheets, for the Great Western Railway. The Stores Superintendent at Swindon.

**Loughlinstown, Ireland,** January 4.—Tanks, the laying of 2,500 yds. of 3-in. cast-iron main, with fountains, etc., and labour, for the Rathdown Rural District Council. Mr. P. H. McCarthy, the engineer, 26, Lower Leeson Street, Dublin.

**Manchester,** January 10.—Woodworking machinery, for the Tramways Committee. Mr. H. Mattinson, general manager and chief engineer, 55, Piccadilly, Manchester.

**Melbourne,** January 18.—Two mortising machines, including motor, etc., one set of chain cutters and hollow mortise chisels, for the Commissioners of the Victorian Government Railways. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,534.)

**Mickleover, Derby,** January 23.—Low-pressure hot-water mains, steam mains, pump-house equipment, etc., for the Derby County Mental Hospital Committee. Messrs. Edwards & Shaw, engineers, 105, Colmore Row, Birmingham. (Fee £1 1s., returnable.)

**Minehead, Somerset,** January 18.—15,000 yds. of 10-in., 9-in., 8-in. and 6-in. pipes, for the Urban District Council. Messrs. A. P. I. Cotterell & Son, engineers, 54, Victoria Street, Westminster, S.W.1. (Fee £5 5s., returnable.)

**Montevideo,** January 20.—1,326 iron columns, complete with cross-arms, for the State Electricity Supply Works. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,518.)

**Montevideo,** January 30.—Supply and installation of two electric pumping sets, for the Port Works Administration. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,655.)

**Swansea,** January 11.—100 yds. of 39-in. diam. cast-iron pipes, turned and bored, 203 yds. of 39-in. diam. cast-iron pipes, spigot and socket, together with manholes, etc., for the Corporation. Mr. J. Richard Heath, the chief engineer, Guildhall, Swansea. (Fee £5 5s., returnable.)

## Obituary.

MR. WILLIAM KING-BAKER, a director of Baker, Perkins, Limited, engineers, died recently at Acton, aged 72 years.

MR. L. GREENING, chairman of directors of Greening & Sons, Limited, wire manufacturers, Warrington, died on December 16 at the age of 72 years.

THE DEATH HAS occurred in Sheffield of Mr. Herbert Wills, of Hastings Road, Millhouses, who was for 25 years a director of Thomas A. Ashton, Limited, engineers, Change Alley. Mr. Wills was 70 years of age.

MESSRS. W. H. WHITE and J. H. INGRAM, brass founders, Halletts Row, Wolverhampton, trading under the style of the Cleveland Casting Company, have dissolved partnership. Mr. J. H. Ingram will continue the business under the same style.

## Personal.

LORD BRABOURNE and Dr. E. P. Andrear have joined the board of the Chemical and Metallurgical Corporation, Limited.

MR. JOHN FERGUSON, of Sir Alexander Gibb and Partners, has been elected a director of British Insulated Cables, Limited.

MR. ROBERT GRANT, JUN., and Mr. Thomas Ivor Jones (a managing director) have retired from the board of Richard Thomas & Company, Limited.

SIR ARTHUR DORMAN, chairman of Dorman, Long & Company, Limited, has sailed for South Africa, in connection with the opening of a new yard by Wade and Dorman at Cape Town.

THE NAME of Sir Francis Joseph has been added to the Commission of the Peace for Staffordshire. He is the head of Settle, Speakman & Company, Limited, colliery proprietors, coal factors and shippers, and a director of the Stafford Coal and Iron Company, Limited. He is also a past-president of the North Staffs Colliery Owners' Association, and of the Coal Trade Benevolent Association.

SIR FREDERICK MILLS, BART., chairman of the Ebbw Vale Steel, Iron and Coal Company, Limited, has appointed Mr. E. Merchant Jenkins as sole agent throughout South Wales and Monmouthshire, the Forest of Dean, and Bristol, for the sale of the company's steel and allied products. Mr. Merchant Jenkins has been all his life in the industry, and has conducted for some years a business as a steel and iron merchant in Port Talbot.

THE BOARD of Sir W. G. Armstrong, Whitworth & Company, Limited, has now been reconstituted as follows:—Lord Southborough, chairman; Mr. J. Frater Taylor, vice-chairman; Sir Eustace Tennyson d'Eyncourt, Mr. J. Ferguson, Sir George Hadcock, Mr. J. Hawson, Lieut.-Col. C. F. Hitchins, Mr. B. Irving, Mr. J. D. Siddeley, and Mr. J. Stewart. Mr. James Stewart, the well-known shipbuilder, will be managing director in charge of shipbuilding, Mr. B. Irving will have control of Scotswood, and Col. Hitchins will remain in charge of commercial sales. Mr. Hawson will be responsible for accounting and finance. An interesting new appointment is that of Mr. Ferguson, one of the partners of Sir Alexander Gibb & Partners, the eminent consulting engineers.

### Wills.

| | |
|---|---|
| SEARBY, J., of the Bridge Foundry, Rawmarsh Road, Rotherham ... ... ... | £9,382 |
| MALLISON, J. W., of Henry Brook & Company, ironfounders, and the Bradford Lead Pipe Company ..... | £34,330 |
| HOWARD, E., of Ardmore, Buckhurst Hill, Essex, chairman of Hayward-Tyler & Company, Limited, engineers, ..... | £27,437 |
| MCNEIL, J., of the Colonial Iron Works, Helen Street, Govan, Glasgow, a director of John McNeil & Company, Limited ..... | £47,287 |
| FRAME, W. H., of Springfield Road, King's Heath, Birmingham, for 53 years associated with Charles Clifford & Sons, Limited, metal manufacturers, of Stirchley ..... | £4,698 |

## Reports and Dividends.

**Greenwood & Batley, Limited.**—Interim dividend, 2½ per cent.

**Butterley Company, Limited.**—Second interim dividend, 2d. per share, free of tax.

**W. and T. Avery, Limited.**—Interim dividend, 5 per cent., less tax., on ordinary shares.

**Cleveland Bridge & Engineering Company, Limited.**—Net profit, £22,590; dividend, 6 per cent.; carry forward, £7,679; brought in, £8,001.

**Redpath, Brown & Company, Limited.**—Profit, £115,616; brought forward, £8,754; depreciation reserve, £15,000; ordinary dividend, 16 per cent., free of tax, for year; bonus, 8 per cent.; staff pension scheme, £5,000; carried forward, £37,870.

**Wm. Beardmore & Company, Limited.**—Report for two years 1925 and 1926: In 1925, loss £43,095; debenture and note interest and other charges, £194,865; total debit for year, less balance brought forward, £192,885; in 1926, loss £540,011; increased by interest, etc., to £760,638; total debit, including 1925, £953,523. Against this £700,000 transferred from general reserve, leaving debit balance end 1926, £253,523.

"SERVICE GRC FIRST"

# WELCOME TO 1928!

MAY THIS LEAP YEAR BE YOUR LUCKY YEAR, AND MAY ITS EXTRA DAY OF WORK BE AN EXTRA DAY OF PROFIT FOR THE BRITISH IRON AND STEEL TRADES AND THEIR FAITHFUL ALLY THE REFRACTORIES INDUSTRY WHICH SHARES THEIR DEPRESSION AND THEIR PROSPERITY.

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# Iron and Steel Markets.

## Pig-Iron.

**MIDDLESBROUGH.**—In accordance with time-honoured tradition, business in the Cleveland iron market has been closed down for the Christmas celebrations. Exactly similar conditions are to be expected over the remainder of the week, but sanguine expectations are entertained on Tees-side of an early improvement in trade in general and in pig-iron particularly, due in some measure to the threatened labour troubles in Germany, which, should a stoppage materialise, would very favourably affect the position of British producers. In that contingency, there would at once develop enormous pressure on other sources of supply, for Germany is still the biggest producer of pig-iron in the old world and the cessation of supplies from that source would mean the ready absorption of all the iron which other countries are immediately capable of producing. It is, however, still regarded as improbable that the dispute will be found incapable of adjustment, and Cleveland's hopes of trade expansion are based upon grounds other than the expectation of a German industrial dispute. Nevertheless, that is a possibility which cannot be ruled out of the calculation, and it may be that many of the inquiries recently circulating in Cleveland are inspired by fears of a stoppage in the Rhenish works. A few foreign orders have, in fact, been booked of late, but Cleveland's first concern is to cultivate the home market, and some encouragement is derived from the receipt of orders for the delivery of Cleveland iron in Lancs. and the Midlands. For the present, prices of Cleveland iron remain stationary as follow:—No. 1 foundry iron, 67s. 6d.; No. 3 G.M.B., 65s.; No. 4 foundry, 64s.; No. 4 forge, 63s. 6d. per ton.

The position in the East Coast hematite market has also developed rather more strength of late, and it now appears that the price has declined to a level which attracts buyers, not only from Sheffield and South Wales, but also in foreign markets. True, French hematite has been sold at lower prices, but the quality has proved disappointing, and a number of foreign buyers, having tried the French material, are returning to the use of East Coast hematite. Some good contracts have recently been booked, and the improvement is such that an expansion of output has been doomed to be justified. Thus Pease & Partners have resolved to stop one of their hematite furnaces at their Normanby ironworks, but to start two at the adjacent Tees ironworks. A net gain of one will increase the total number of blast-furnaces operating on the North-East Coast to forty, of which twelve will be on hematite, sixteen on Cleveland, and twelve on other kinds of iron.

**LANCASHIRE.**—Although actual buying of foundry material is in abeyance over the holiday season, signs are not wanting of a hopeful revival of demand in the early part of the New Year, and more inquiries have been recently reported than for some time past. This movement has doubtless been encouraged by the low levels of current values, which are now very little, if anything, above the "low" for the past year. For example, Derbyshire No. 3 brands are now quoted at 73s. 6d., Staffordshire at about 72s. 6d., with Cleveland at around 78s., Scottish from 88s. upwards, and hematite at a maximum of 85s. per ton for West Coast brands, all delivered Manchester or equal.

**THE MIDLANDS.**—In this area prices of foundry pig are not at all firm, and there is no doubt that concessions would be given by the furnaces if sufficient inducements were offered. Many of the iron-founders are themselves short of work, and, although they are carrying little or no stock, they are not at all anxious buyers. No. 3 Northamptonshire can still be obtained at about 60s. at furnaces, and Derbyshire is obtained readily at 65s., with North Staffordshire No. 3 at 64s. 6d. to 65s. at furnaces.

**SCOTLAND.**—As markets in this area do not close for holidays until later than is customary in the South, there is still a limited business passing in Scottish foundry iron, but consumers continue to buy sparingly, and a still further shrinkage in business is looked for over the next week or two. The price of No. 3 foundry is again shaded to 71s. at furnaces, and makers are doing their utmost to arrest the decline, but are so keen to avoid stocking that they are induced in some cases to succumb to the pressure put upon them to cut prices still further.

## Finished Iron.

Lancashire makers of bars iron report a quiet trade, and they are not too hopeful of any immediate improvement in the situation. There is no alteration in prices, however, the Lancashire Association figures remaining at £10 per ton for crown bars and £9 10s. for seconds. Merchant parcels of the former are still quoted on the basis of 14s. per cwt., less 2½ per cent., and including delivery to buyers' works.

## Steel.

As far as home steel products are concerned, although values of joists and sections are fully maintained at £7 12s. 6d. per ton, and of ship and tank plates at £8 7s. 6d., for Lancashire makes, there have latterly been some lower offers of boiler plates, the top prices for these now being at around £10 5s. per ton, a figure which, in all probability, would be shaded still further if there were sufficient inducement in the way of business. Steel bars also are easy, and £7 10s. per ton for the small re-rolled varieties is now fairly general, with up to £8 10s. being asked for other sizes. Almost the entire demand recently has been on early delivery account. The buyers' point of view is that the price position is too uncertain to justify venturing any distance ahead. The tone of the tinplate market has been fairly steady, and it is expected that a renewal of buying will take place after the holidays. Current quotations for coke tinplates may now be called firm at 18s. to 18s. 3d. basis for approved specifications net, f.o.b. Wales.

## Metals.

**Copper.**—The upward tendency of values observed in previous reports of the base metal markets is mostly maintained, but in the case of standard copper a slight reaction has developed, although the placing of any important orders by consumers for early delivery is not an easy matter.

Official closing prices of standard copper have been as follow:—

*Cash*: Thursday, £60 5s. to £60 6s. 3d.; Friday, £60 10s. to £60 11s. 3d.; Wednesday, £60 17s. 6d. to £60 18s. 3d.

*Three Months*: Thursday, £60 8s. 9d. to £60 10s.; Friday, £60 12s. 6d. to £60 13s. 9d.; Wednesday, £61 to £61 1s. 3d.

**Tin.**—Although the business reported in standard tin of late has not been on a heavy scale, prices have remained fairly steady, and consistent with the statistical position of the metal, upon which any market improvement must be based.

Official closing prices of standard tin have been as under:—

*Cash*: Thursday, £265 15s. to £265 17s. 6d.; Friday, £266 15s. to £267; Wednesday, £266 to £266 5s.

*Three Months*: Thursday, £263 7s. 6d. to £263 10s.; Friday, £262 10s. to £262 12s. 6d.; Wednesday, £261 5s. to £261 10s.

**Spelter.**—While ordinary spelter has declined lately, the fall has not been so pronounced as in some other metals. Quite recently there was rather a sharp rise owing to the strike in Australia, and the possibility of ore supplies and purity spelter being held up the premiums on the latter, in consequence, increased to £3 and £4, according to delivery.

The following are the week's prices:—

*Ordinary*: Thursday, £26 3s. 9d.; Friday, £26 3s. 9d.; Wednesday, £26 7s. 6d

**Lead.**—The market for soft foreign has disclosed little change of late, but, on the whole, may now be regarded as having acquired a more satisfactory position than was at one time anticipated, demand on home consumptive account indicating an early improvement in volume, with stocks in warehouse not being greatly above the average.

The week's prices are appended:—

*Soft foreign (prompt)*: Thursday, £22 2s. 6d.; Friday, £22 2s. 6d.; Wednesday, £22 6s. 3d.

## New Companies.

**Morton Alexander, Limited.**—Capital £100 in £1 shares. Business of motor, mechanical, electrical, constructional and general engineers, metal workers, etc. Secretary: H. M. Alexander, Town Hall Chambers, New Street, Birmingham.

**Alma Gear, Limited.**—Capital £100 in £1 shares. To acquire patents for improvements in buffing and draw gear for railway vehicles, etc. Solicitors: A. M. Oppenheimer, 31, Queen Victoria Street, E.C.4.

**Anglo-Dutch Engineering Company, Limited.**—Capital £10,000 in £1 shares. Directors: H. Lonsdale, 18, Park Road, West Dulwich, S.E.21, and C. Faber.

**Birtley Iron Company, Limited.**—Capital £60,000 in £1 shares, to take over business of ironfounders, wagon-builders, manufacturers of colliery and mining plant, etc., carried on at Birtley, Durham, as the Birtley Iron Company, to acquire patent rights under agreement between Hugh Wood & Company, Limited, and others. Directors: Sir Joseph F. Laycock, J. D. Cawley, Snowshill Hill, Moreton-in-Marsh, Gloucester; and K. C. Appleyard, Birtley Springs House, Birtley, Co. Durham.

**British Institute of Engineering Technology, Limited,** 40, Leicester Square, W.C.2.—Capital £2,000 in £1 shares. Director: T. Aubertin.

**Corthesy Smoke Consuming Syndicate, Limited,** 53, New Broad Street, E.C.2.—Capital £2,000 (1,000 ordinary of £1 and 20,000 deferred of 1s.). Directors: J. H. Corthesy, A. W. Mills and J. Y. Elliott.

**Davum Steel Company, Limited.**—Capital £2,000. Provisional directors: P. L. Bonlard and J. A. Steemson, 35, Auckland Road, S.W.11.

**A. De Barsy, Limited.**—Capital £1,000 in £1 shares, to acquire business of A. De Barsy, Dashwood House, E.C. Dealers in metals, etc.

**Harry Jones & Son, Limited,** Lloyds Bank Chambers, Middlesbrough.—Capital £1,000 in £1 shares. To acquire business at Middlesbrough as Harry Jones, and to carry on business of dealers in coal, coke, iron, steel and other metals, etc. H. Jones, permanent governing director and chairman.

**Lockyer, Evans & Company, Limited,** 36, Friday Street, E.C.—Capital £255 in 250 £1 6 per cent. cumulative preference and 100 1s. ordinary. Agents for manufacturers of steel, hardware, etc. Directors, B. G. H. B. Lockyer and L. O. C. Evans.

**F. & H. Matchett, Limited,** George Street, Birmingham.—Capital £32,000 in £1 shares, to acquire business carried on by A. T. Matchett as F. & H. Matchett at George Street, Birmingham. Brass and iron workers, etc.

**Donald McGregor, Limited.**—Capital £6,000. Agricultural and industrial machinery merchants, carried on at 18, Merchants' Quay, Cork. Directors: D. McGregor (managing director), Mrs. Christine McGregor and J. F. Knox.

**Rupert H. Pickles, Limited,** Empress Foundry, Mytholmroyd, Yorks.—Capital £5,000 in £1 shares. Ironfounders.

**Ryding Fire Clay Company, Limited,** Brackenhirst Works, Airdrie, Lanarkshire.—Capital £5,000. Directors: W. S. Morton and R. M. Morton.

**Smith & Morgan (West Bromwich), Limited,** 34A, Barrows Street, West Bromwich.—Capital £1,500 in £1 shares. Brassfounders and engineers, etc.

**Stephens Silica Brick, Limited.**—Capital £100,000 (40,000 6 per cent. cumulative preference and 60,000 ordinary), to acquire business carried on by Sir Alfred Stephens at Kidwelly, Carmarthenshire, as Stephens & Company.

**A. Walker & Company, Limited,** 67, Blackett Street, Newcastle-on-Tyne.—Capital £5,000 in £1 shares. Scale manufacturers.

**Robert Warner (Pumps), Limited,** Pottery Lane, Newcastle-upon-Tyne.—Capital £100 in £1 shares, to adopt an agreement between W. R. Silk, C. B. Trewhella and F. W. Poynor and E. Ayres & Company, Limited. Engineers, etc.

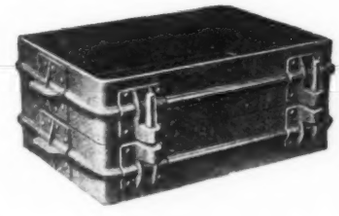
---

**Duralumin Mine Tubs in Germany.**—The use of duralumin for mine tubs and coal baskets at collieries instead of steel is extending rapidly in Germany. The tubs and baskets of duralumin are said to weigh only about one-third of steel, and effect a considerable saving in power, wire rope and other costs. As many German mines are rather deep, the new metal, which is acid-resisting, is being introduced. Tubs made of this metal were exhibited by the Emil Wolff firm, of Essen, at the recent exhibition of working materials in Berlin.

Sterling

# ROLLED STEEL BOXES

## FOR EVERY FOUNDRY SERVICE.



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Guaranteed absolutely rigid.

Made to any desired limits of accuracy.

Cannot crack or break.

Cannot distort or get out of shape.

Permanently accurate.

Made from solid ribbed rolled steel ensuring long life.

YOU CANNOT AFFORD TO IGNORE THESE ADVANTAGES.

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# STERLINGS

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# WEEKLY PRICE CURRENT.

## COPPER.

| | £ s. d. |
|---|---|
| Standard cash | 60 17 6 |
| Three months | 61 0 0 |
| Electrolytic | 66 10 0 |
| Tough | 65 0 0 |
| Best selected | 65 10 0 |
| Sheets | 90 0 0 |
| India | 75 0 0 |
| Wire bars | 67 0 0 |
| Do. January | 66 15 0 |
| Do. February | 66 15 0 |
| Ingot bars | 66 15 0 |
| H.C. Wire rods | 70 15 0 |
| Off. av. cash, Nov. | 59 17 3 3/11 |
| Do. 3 mths., Nov. | 58 18 0 11/24 |
| Do., Sttlmnt., Nov. | 58 17 3 3/11 |
| Do., Electro, Nov. | 63 19 6 6/11 |
| Do., B.S., Nov. | 63 8 7½ |
| Aver. spot price, copper, Nov. | 58 17 3½ |
| Do., Wire bars, Nov. | 64 3 10½ |
| Solid drawn tubes | 12½d. |
| Brazed tubes | 12½d. |
| Wire | 9½d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 11½d. |
| Brazed tubes | 13½d. |
| Rods, drawn | 10½d. |
| Rods, extd. or rlld. | 7½d. |
| Sheets to 10 w.g. | 10½d. |
| Wire | 9½d. |
| Rolled metal | 9½d. |
| Yellow metal rods | 7½d. |
| Do. 4 × 4 Squares | 8d. |
| Do. 4 × 3 Sheets | 8½d. |

## TIN.

| | £ s. d. |
|---|---|
| Standard cash | 266 0 0 |
| Three months | 261 5 0 |
| English | 265 0 0 |
| Bars | 266 15 0 |
| Straits | 266 15 0 |
| Australian | 270 15 0 |
| Eastern | 265 15 0 |
| Banca | 267 15 0 |
| Off. av. cash, Nov. | 262 13 9 13/24 |
| Do., 3 mths., Nov. | 258 11 9 23/24 |
| Do., Sttlmt., Nov. | 262 13 2 7/11 |
| Aver. spot, Nov. | 262 13 9½ |

## SPELTER.

| | £ s. d. |
|---|---|
| Ordinary | 26 7 6 |
| Remelted | 26 0 0 |
| Hard | 21 0 0 |
| Electro 99.9 | 31 0 0 |
| English | 26 10 0 |
| India | 22 10 0 |
| Zinc dust | 35 0 0 |
| Zinc ashes | 9 0 0 |
| Off. aver., Nov. | 26 2 10 12/24 |
| Aver., spot, Nov. | 26 5 7½ |

## LEAD.

| | £ s. d. |
|---|---|
| Soft foreign ppt. | 22 6 3 |
| English | 23 10 0 |
| Off. average, Nov. | 21 2 0 23/24 |
| Average spot, Nov. | 20 17 9½ |

## ZINC SHEETS, &c.

| | £ s. d. |
|---|---|
| Zinc sheets, English | 35 0 0 |
| Do. V.M. ex whf. | 33 5 0 |
| Rods | 42 0 0 |
| Boiler plates | 30 10 0 |
| Battery plates | 32 0 0 |

## ANTIMONY.

| | £ s. d. |
|---|---|
| Special brands, Eng. | 64 10 0 |
| Chinese | 41 10 0 |
| Crude | 37 0 0 |

## QUICKSILVER.

| | £ s. d. |
|---|---|
| Quicksilver | 23 0 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro-silicon— | |
| 25% | £8 17 6 |
| 45/50% | £12 17 6 |
| 75% | £21 17 6 |
| Ferro-vanadium— | |
| 35/40% | 14/3 lb. va. |
| Ferro-molybdenum— | |
| 70/75% c. free | 5/- lb. |
| Ferro-titanium— | |
| 23/25% carbonless | 11½d |
| Ferro-phosphorus, 20/25% | £17 15 0 |
| Ferro-tungsten— | |
| 80/85%, c. fr. | 1/4 lb. |
| Tungsten metal powder— | |
| 98/99% | 1/8 lb. |
| Ferro-chrome— | |
| 2/4% car. | £33 0 0 |
| 4/6% car. | £23 0 0 |
| 6/8% car. | £22 17 6 |
| 8/10% car. | £22 10 0 |
| Ferro-chrome— | |
| Max. 2% car. | £35 17 6 |
| Max. 1% car | £41 12 6 |
| Max. 0.70% car | £52 -0 0 |
| 70% carbonless | 1/4 lb. |
| Nickel—99% cubes or pellets | £170 0 0 to £175 0 0 |
| Ferro-cobalt | 9/3 lb. |
| Aluminium 98/99% | £105 0 0 |
| Metallic chromium— | |
| 96/98% | 2/11 lb. |
| Ferro-manganese (net)— | |
| 76/80%, loose | £13 10 0 |
| 76/80%, packed | £14 10 0 |
| 76/80%, export | £12 0 0 |
| Metallic manganese— | |
| 94/96%, carbonless | 1/10 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | £0 2 6 |
| Finished bars, 18% tungsten | £0 3 0 |

Per lb. net, d/d buyers' works.

| | |
|---|---|
| Extras— | |
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to ⅛ in. | 1/- lb. |
| Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. | 3d. lb. |
| Do., under ½ in. × ¼ in. | 1/-lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

| | |
|---|---|
| Scrap from high-speed tool steel— | |
| Scrap pieces | 3d. |
| Turnings and swarf | 1d. |

Per lb. net, d/d steel makers' works.

## SCRAP.

| | £ s. d. to £ s. d. |
|---|---|
| South Wales— | |
| Hvy. steel | 3 0 0 to 3 2 6 |
| Bundled steel and shrngs. | 2 14 0 to 2 18 6 |
| Mixed iron and steel | 2 14 0 to 2 15 0 |
| Heavy cast iron | 2 17 6 to 2 19 0 |
| Good machinery for foundries | 3 0 0 to 3 2 6 |
| Cleveland— | |
| Heavy steel | 2 17 6 |
| Steel turnings | 2 6 0 |
| Cast iron borings | 2 3 0 |
| Heavy forge | 3 12 6 |
| Bushelled scrap | 3 2 6 |
| Cast-iron scrap | 3 2 6 to 3 6 0 |
| Lancashire— | |
| Cast-iron scrap | 3 5 0 |
| Hvy. wrought | 3 2 6 |
| Steel turnings | 2 2 6 |

London—Merchants' buying prices delivered yard.

| | £ s. d. |
|---|---|
| Copper (clean) | 51 0 0 |
| Brass (clean) | 38 0 0 |
| Lead (less usual draft) | 19 0 0 |
| Tea lead | 16 0 0 |
| Zinc | 17 0 0 |
| New aluminium cuttings | 76 0 0 |
| Braziery copper | 47 0 0 |
| Gunmetal | 48 0 0 |
| Hollow pewter | 170 0 0 |
| Shaped black pewter | 130 0 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast— | |
| Foundry No. 1 | 67/6 |
| Foundry No. 3 | 65/- |
| Foundry No. 4 | 64/- |
| Forge No. 4 | 63/6 |
| Hematite No. 1 | 71/6 |
| Hematite M/Nos. | 71/- |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 83/- |
| ,, d/d Birm. | 89/- to 90/- |
| Midlands— | |
| Staffs. common* | — |
| ,, No. 4 forge | 62/6 |
| ,, No. 3 fdry. | 64/- to 65/- |
| Shrops. basic | — |
| ,, Cold blast, ord.* | — |
| ,, ,, roll iron* | — |
| * d/d Birmingham. | |
| Northants forge | 54/- |
| ,, fdry. No. 3 | 58/6 to 60/- |
| Derbyshire forge | 60/- |
| ,, fdry. No. 3 | 64/- to 65/- |
| ,, basic | — |
| Scotland— | |
| Foundry No. 1 | — |
| ,, No. 3 | 71/- |
| Hem. M/Nos. | 74/6 |
| Sheffield (d/d district)— | |
| Derby forge | 65/- |
| ,, fdry. No. 3 | 68/- |
| Lincs. forge | 65/- |
| ,, fdry. No. 3 | 68/- |
| E.C. hematite | 84/6 |
| W.C. hematite | 89/6 |
| Lincs. (at furnaces)— | |
| Forge No. 4 | — |
| Foundry No. 3 | — |
| Basic | — |
| Lancashire (d/d eq. Man.)— | |
| Derby forge | — |
| ,, fdry. No. 3 | 73/- |
| Northants foundry No. 3 | — |
| Dalzell, No. 3 | 100/- to 102/6 |
| Summerlee, No. 3 | 88/- to 94/- |
| Glengarnock, No. 3 | 88/- to 94/- |
| Gartsherrie, No. 3 | 88/- to 94/- |
| Monkland, No. 3 | 88/- to 94/- |
| Coltness, No. 3 | 88/- to 94/- |
| Shotts, No. 3 | 88/- to 94/- |

## FINISHED IRON AND STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| Iron— | £ s. d. to £ s. d. |
|---|---|
| Bars (cr.) nom. | 9 15 0 to 10 15 0 |
| Angles | — |
| Tees to 3 united ins. | — |
| Nut and bolt iron | 9 0 0 |
| Hoops | 12 10 0 |
| Marked bars (Staffs.) f.o.t. | 13 0 0 |
| Gas strip | 12 0 0 |
| Bolts and nuts, ¾ in. × 4 in. | 15 5 0 |
| Steel— | |
| Ship plates | 8 2 6 to 8 7 6 |
| Boiler plts. | 10 10 0 |
| Chequer plts. | 10 5 0 |
| Angles | 7 12 6 |
| Tees | 8 12 6 |
| Joists | 7 12 6 |
| Rounds and squares, 3 in. to 5½ in. | 7 15 0 |
| Rounds under 3 in. to ¾ in. (Untested) | 8 0 0 and upwards |
| Flats, over 5 in. wide and up | 9 2 6 |
| Flats, 5 in. to 1½ in. | 8 2 6 |
| Rails, heavy | 8 2 6 to 8 7 6 |
| Fishplates | 12 10 0 |
| Hoops (Staffs.) | 10 10 0 |
| Black sheets, 24g. | 10 2 6 |
| Galv. cor. shts., 24g. | 13 0 0 |
| Galv. fencing wire 8g. plain | 12 10 0 |
| Billets, soft | £6 0 0 to 6 10 0 |
| Billets, hard | 8 2 6 |
| Sheet bars | £5 12 6 to 5 15 0 |
| Tin bars | £5 12 6 to 5 15 0 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 1 2½ |
| Sheet to 10 w.g. | 1 3 |
| Wire | 1 3¾ |
| Rods | 1 3 |
| Tubes | 1 8½ |
| Castings | 1 2 |

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | per lb. |
|---|---|
| Ingots for raising | 9d. to 1/3 |
| Rolled— | |
| To 9 in. wide | 1/3 to 1/9 |
| To 12 in. wide | 1/3½ to 1/9½ |
| To 15 in. wide | 1/3½ to 1/9½ |
| To 18 in. wide | 1/4 to 1/10 |
| To 21 in. wide | 1/4½ to 1/10½ |
| To 25 in. wide | 1/5 to 1/11 |
| Ingots for spoons and forks | 9d. to 1/5½ |
| Ingots rolled to spoon size | 1/- to 1/8½ |
| Wire round— | |
| 3/0 to 10 G. | 1/6½ to 2/1½ |

with extras according to gauge.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2X foundry, Phila. | 19.76 |
| No. 2 foundry, Valley | 17.25 |
| No. 2 foundry, Birm. | 16.00 |
| Basic | 18.76 |
| Bessemer | 19.51 |
| Malleable | 18.26 |
| Grey forge | 18.51 |
| Ferro-mang. 80% d/d | 100.00 |
| Bess rails, h'y, at mill | 43.00 |
| O.-h. rails, h'y at mill | 43.00 |
| Bess billets | 33.00 |
| O.-h. billets | 33.00 |
| O.-h. sheet bars | 34.00 |
| Wire rods | 40.00 |
| | Cents. |
| Iron bars, Phila. | 2.12 |
| Steel bars | 1.80 |
| Tank plates | 1.80 |
| Beams, etc. | 1.80 |
| Skelp, grooved steel | 1.80 |
| Skelp, sheared steel | 1.80 |
| Steel hoops | 2.20 |
| Sheets, black, No. 24 | 2.75 |
| Sheets, galv., No. 24 | 3.60 |
| Sheets, blue an'l'd., 9 and 10 | 2.10 |
| Wire nails | 2.50 |
| Plain wire | 2.40 |
| Barbed wire, galv. | 3.20 |
| Tinplate, 100 lb. box | $5.25 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | — |
| ,, furnace | — |
| Durham and North. | |
| ,, foundry | — |
| ,, furnace | 13/6 |
| Other Districts, foundry | — |
| ,, ,, furnace (basis) | 12/- |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | | |
|---|---|---|---|
| I.C. Cokes | 20×14 | box | 18/3 |
| ,, | 28×20 | ,, | 36/6 |
| ,, | 20×10 | ,, | — |
| ,, | 18⅞×14 | ,, | — |
| C.W. | 20×14 | ,, | 17/4½ |
| ,, | 28×20 | ,, | — |
| ,, | 20×10 | ,, | — |
| ,, | 18⅞×14 | ,, | — |
| Terneplates | 28×20 | — | per box basis f.o.b. |

## SWEDISH IRON.

| | |
|---|---|
| Bars, hammered, £18 10 0 to 19 0 0 | |
| Rolled Ord. | £15 0 0 to £15 10 0 |
| Nail rods | £15 7 6 to £15 15 0 |
| Keg. steel nom. | £33 to £35 |
| Faggot steel nom. | £22 to £25 |
| Blooms, according to quality | £8 to £12 |
| Pig-iron | £5 15 0 to ; |

all f.o.b. Gothenburg.

### TUBES AND FITTINGS.

Up to and incl. 6 in.

| | *Tubes.* | *Fittings.* |
|---|---|---|
| Gas .. .. | 67½% .. | 45% |
| Water .. .. | 63⅔% .. .. | 40% |
| Steam .. .. | 60% .. .. | 35% |

W.I. 10% extra.

### DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 60 5 0 | inc. 10/– |
| „ 23 .. | 60 10 0 | „ 5/– |
| „ 28 .. | 60 17 6 | „ 7/6 |

**Electrolytic Copper.**

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 66 10 0 | inc. 5/– |
| „ 23 .. | 66 10 0 | No change |
| „ 28 .. | 66 10 0 | „ „ |

**Standard Tin** (cash).

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 265 15 0 | dec. 15/– |
| „ 23 .. | 266 15 0 | inc. 20/– |
| „ 28 .. | 266 0 0 | dec. 15/– |

**Tin** (English ingots).

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 264 5 0 | dec. 15/– |
| „ 23 .. | 264 15 0 | inc. 10/– |
| „ 28 .. | 265 0 0 | „ 5/– |

**Zinc Sheets** (English)

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 35 0 0 | No change |
| „ 23 .. | 35 0 0 | „ „ |
| „ 28 .. | 35 0 0 | „ „ |

**Spelter** (ordinary).

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 26 3 9 | No change |
| „ 23 .. | 26 3 9 | „ „ |
| „ 28 .. | 26 7 6 | inc. 3/9 |

**Lead** (English).

| | £ s. d. | |
|---|---|---|
| Dec. 22 .. | 23 5 0 | No change |
| „ 23 .. | 23 5 0 | „ „ |
| „ 28 .. | 23 10 0 | inc. 5/– |

### AVERAGE MONTHLY PRICES OF SIEMENS TINPLATE BARS (S. WALES).

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1896 .. .. | 4 0 0 | 4 0 0 | 3 18 0 | 3 18 0 | 3 18 0 | 3 18 0 | 4 2 6 | 4 7 6 | 4 7 6 | 4 10 0 | 4 7 6 | 4 7 6 | 4 2 1 |
| 1897 .. .. | 4 10 0 | 4 12 9 | 4 10 0 | 4 7 6 | 4 7 0 | 4 2 6 | 4 2 6 | 4 2 6 | 4 2 6 | 4 0 0 | 4 2 6 | 4 2 6 | 4 5 2½ |
| 1898 .. .. | 4 2 6 | 4 2 6 | 4 2 6 | 4 2 6 | 4 10 0 | 4 10 0 | 4 10 0 | 4 10 0 | 4 10 0 | 4 10 0 | 4 12 6 | 4 12 6 | 4 7 11 |
| 1899 .. .. | 4 15 0 | 4 15 0 | 4 12 6 | 4 12 6 | 4 15 0 | 4 17 6 | 5 15 0 | 6 2 6 | 6 5 0 | 6 7 6 | 6 7 6 | 6 12 6 | 5 9 11 |
| 1900 .. .. | 7 2 6 | 7 7 6 | 7 7 6 | 7 10 0 | 7 7 6 | 7 7 6 | 7 5 0 | 7 0 0 | 7 0 0 | 7 0 0 | 7 0 0 | 5 7 6 | 7 1 3 |
| 1901 .. .. | 5 5 0 | 5 5 0 | 5 5 0 | 4 17 6 | 4 15 0 | 5 0 0 | 5 2 6 | 5 2 6 | 5 5 0 | 5 2 6 | 5 2 6 | 5 0 0 | 5 1 10½ |
| 1902 .. .. | 4 17 6 | 5 0 0 | 5 5 0 | 5 5 0 | 5 5 0 | 5 5 0 | 5 2 6 | 5 2 6 | 4 17 6 | 4 17 6 | 4 15 0 | 4 15 0 | 5 0 7 |
| 1903 .. .. | 4 15 0 | 4 15 0 | 4 15 0 | 4 15 0 | 4 17 6 | 4 17 6 | 4 17 6 | 4 15 0 | 4 15 0 | 4 12 6 | 4 12 6 | 4 7 6 | 4 14 7 |
| 1904 .. .. | 4 7 6 | 4 7 6 | 4 7 6 | 4 7 6 | 4 12 6 | 4 12 6 | 4 7 6 | 4 7 6 | 4 7 6 | 4 5 0 | 4 5 0 | 4 5 0 | 4 7 2½ |
| 1905 .. .. | 4 7 6 | 4 8 9 | 4 7 6 | 4 7 6 | 4 7 6 | 4 10 0 | 4 6 6 | 4 6 6 | 4 7 6 | 4 10 0 | 5 0 0 | 5 0 0 | 4 8 3 |
| 1906 .. .. | 5 5 0 | 5 5 0 | 5 2 6 | 4 17 6 | 4 17 6 | 5 0 0 | 5 0 0 | 5 0 0 | 5 0 0 | 5 2 6 | 5 7 6 | 5 17 6 | 5 2 11 |
| 1907 .. .. | 5 17 6 | 6 0 0 | 6 0 0 | 6 0 0 | 6 2 6 | 6 5 0 | 6 5 0 | 6 5 0 | 6 5 0 | 5 17 6 | 5 12 6 | 5 5 0 | 5 19 7 |
| 1908 .. .. | 5 0 0 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 11 6 | 4 10 0 | 4 7 6 | 4 7 6 | 4 10 0 | 4 8 9 | 4 10 0 | 4 11 3 |
| 1909 .. .. | 4 10 0 | 4 8 9 | 4 7 6 | 4 7 6 | 4 7 6 | 4 8 9 | 4 10 0 | 4 8 9 | 4 10 0 | 4 12 6 | 4 13 9 | 4 15 0 | 4 10 0 |
| 1910 .. .. | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 | 5 2 6 |
| 1911 .. .. | 5 3 9 | 5 5 0 | 5 4 6 | 5 1 10 | 5 0 0 | 5 0 0 | 5 0 0 | 5 0 0 | 5 0 0 | 5 0 0 | 4 18 9 | 4 17 6 | 5 0 10 |
| 1912 .. .. | 5 1 3 | 5 2 6 | 5 5 0 | 5 5 0 | 5 10 0 | 5 11 10 | 5 14 4 | 5 15 0 | 5 15 7 | 5 17 6 | 5 17 6 | 5 17 6 | 5 11 1 |
| 1913 .. .. | 5 17 6 | 5 17 6 | 5 12 6 | 5 12 6 | 5 9 6 | 5 5 0 | 5 5 0 | 4 16 3 | 4 16 3 | 4 16 3 | 4 16 3 | 4 11 3 | 5 5 3 |
| 1914 .. .. | 4 11 3 | 4 11 3 | 4 11 3 | 4 11 3 | 4 11 3 | 4 11 3 | 4 11 3 | 4 16 3 | 5 2 6 | 4 19 6 | 4 15 0 | 4 15 0 | 4 13 11 |
| 1915 .. .. | 5 4 3 | 6 5 0 | 6 15 0 | 7 5 6 | 7 9 4½ | 7 7 2 | 7 6 0 | 7 4 8 | 7 1 10½ | 7 4 0 | 8 15 0 | 8 12 6 | 7 7 7 |
| 1916 .. .. | 11 6 10½ | 11 14 4½ | 12 7 0 | 11 3 1½ | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 15 11½ |
| 1917 .. .. | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 |
| 1918 .. .. | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 | 10 7 6 |
| 1919 .. .. | 10 10 6 | 11 12 6 | 12 5 0 | 12 5 0 | 13 10 0 | 13 9 4½ | 13 10 7½ | 14 0 0 | 14 0 0 | 14 0 0 | 15 2 6 | 16 3 1 | 13 7 8½ |
| 1920 .. .. | 18 15 0 | 25 5 0 | 31 0 0 | 30 15 0 | 30 5 0 | 30 0 0 | 25 10 0 | 23 10 0 | 23 0 0 | 20 15 0 | 18 5 0 | 18 0 0 | 24 13 4 |
| 1921 .. .. | 17 10 0 | 15 5 0 | 14 10 0 | 13 0 0 | 12 5 0 | 11 10 0 | 10 6 0 | 8 15 0 | 8 10 0 | 8 5 0 | 7 15 0 | 17 15 0 | 11 5 6 |
| 1922 .. .. | 7 9 4½ | 7 7 6 | 7 7 6 | 7 7 6 | 7 7 6 | 7 7 6 | 7 7 6 | 7 7 6 | 7 7 6 | 7 5 7½ | 7 3 9 | 7 9 1½ | 7 7 2½ |
| 1923 .. .. | 7 17 3½ | 8 3 6 | 8 18 9½ | 10 0 0 | 9 9 6 | 9 2 6 | 9 2 6 | 9 2 6 | 9 2 6 | 9 2 6 | 9 1 0 | 8 18 9 | 9 0 1½ |
| 1924 .. .. | 8 18 9 | 8 18 9 | 8 18 9 | 8 18 9 | 8 18 9 | 8 12 6 | 8 12 6 | 8 11 7½ | 8 11 7½ | 8 12 6 | 8 11 3 | 8 7 6 | 8 14 5½ |
| 1925 .. .. | 8 7 6 | 8 3 3 | 7 17 6 | 7 17 6 | 6 16 10½ | 6 13 9 | 6 13 9 | 6 13 5½ | 6 10 11½ | 6 8 0 | 6 15 0 | 6 5 0 | 7 1 10½ |
| 1926 .. .. | 6 4 8½ | 6 3 9 | 6 3 9 | 6 3 9 | 6 3 9 | 6 4 0½ | 6 5 0 | 6 5 0 | 6 14 0 | 7 7 6 | 7 10 0 | 7 6 6 | 6 10 11½ |
| 1927 .. .. | 6 15 0 | 6 15 0 | 6 10 0 | 6 10 0 | 6 7 6 | 6 5 6 | 6 0 0 | 5 14 0 | 5 13 9 | 5 13 9 | 5 13 9 | — | 6 3 5½ |


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|---|---|
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| 8 TON EVANS, good .. .. | £40 |
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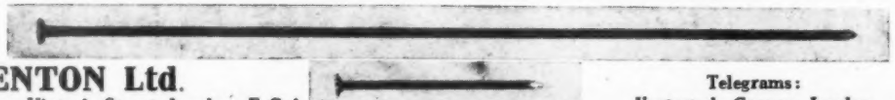

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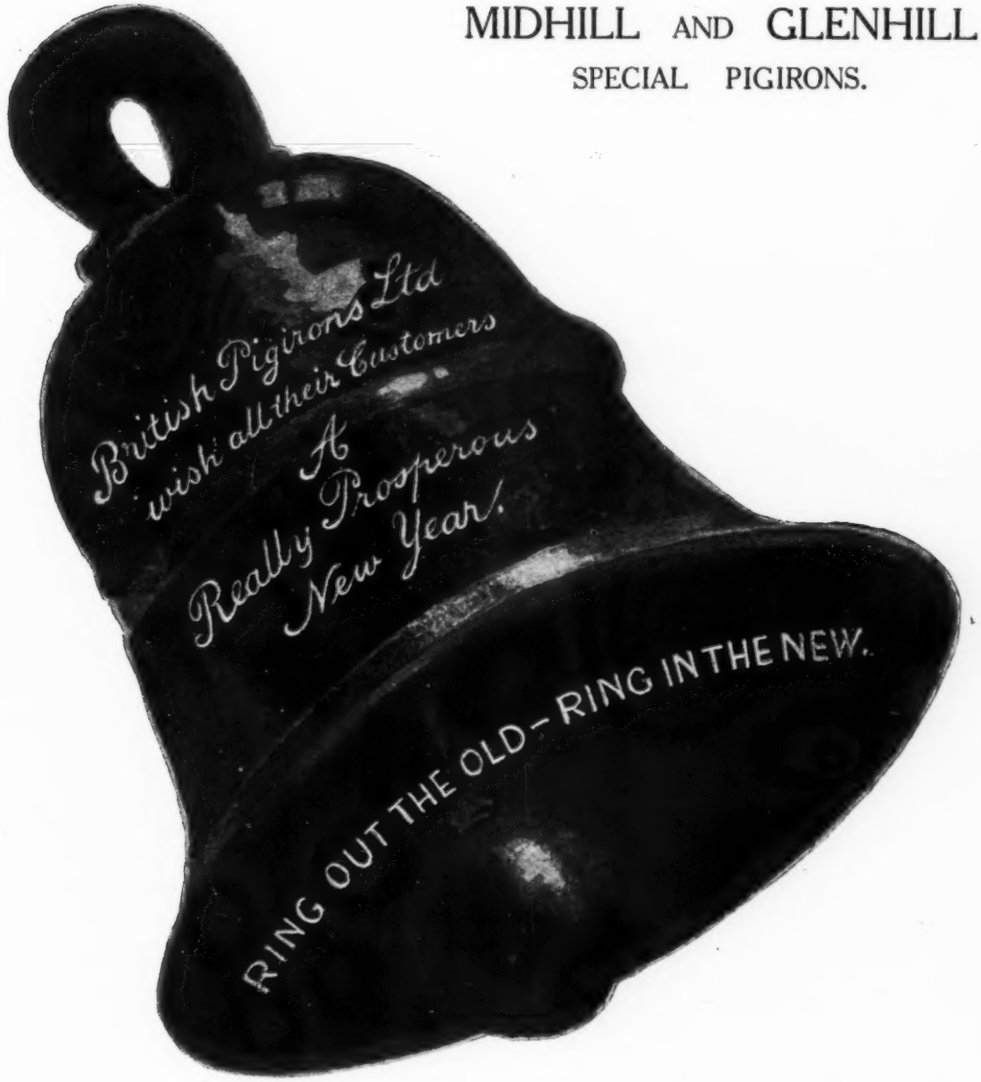

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## Installing Portable Sand Slingers

*Friday Afternoon.* **Portable Sand Slinger** dispatched from our works by road.

*Saturday Forenoon.* Machine delivered at Customer's Foundry. Erected and given trial run.

*Monday Morning.* Machine rammed mould of large Engine trunk in moulding box 10ft. by 6ft. by 2ft. 6in. deep.

Time—3 Men, 29 minutes. Say, 1½ Man Hours.

During the previous week the same pattern was rammed up in same box by hand—Time—4 Moulders, 8 Hours. Say, 32 Man Hours.

***NOTE.***

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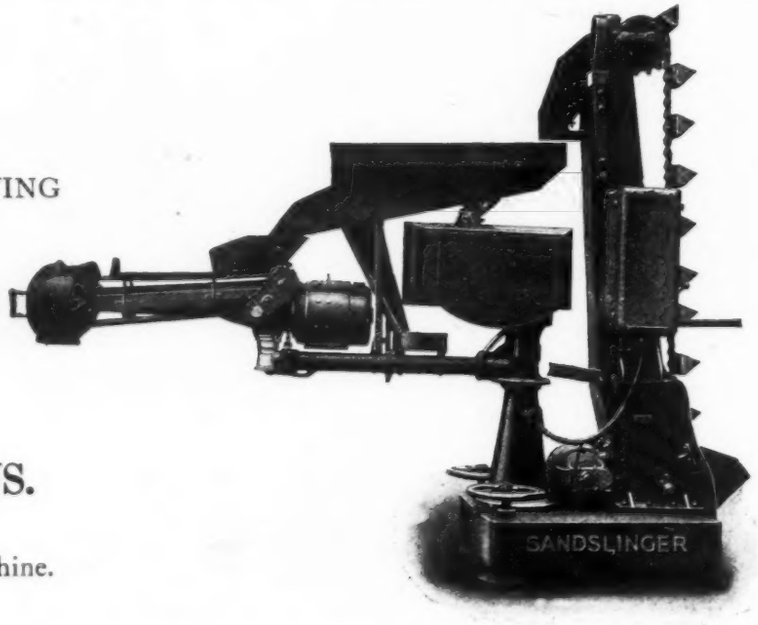


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***Advantages :***

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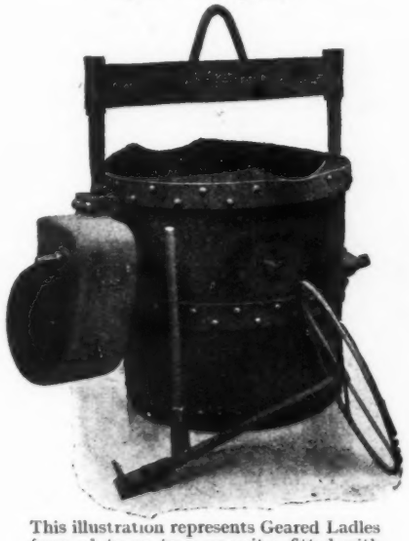
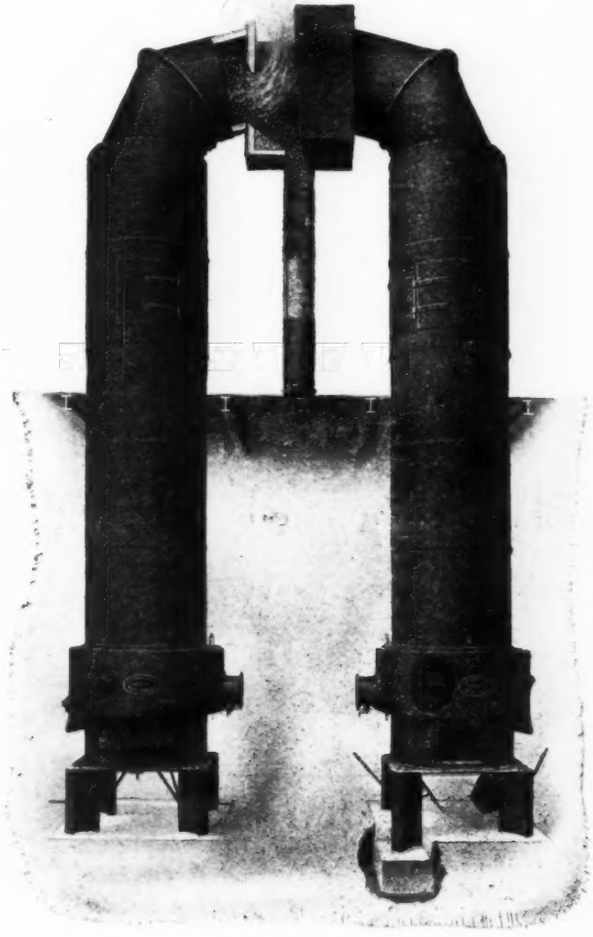
Can be fitted to existing Cupolas.

This illustration represents Geared Ladles up to 2 tons capacity.



This illustration represents Geared Ladles from 2¼ to 10 tons capacity, fitted with oil-tight gear cover.



Two Drop Bottom Rapid Cupolas, and Duplex Osborn Patent Spark Arrester, with down-take tube to conduct the dust down to, or through the charging platform.

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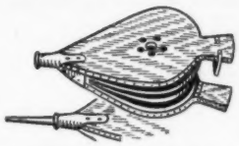

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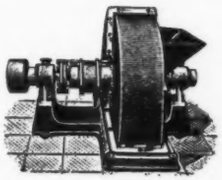

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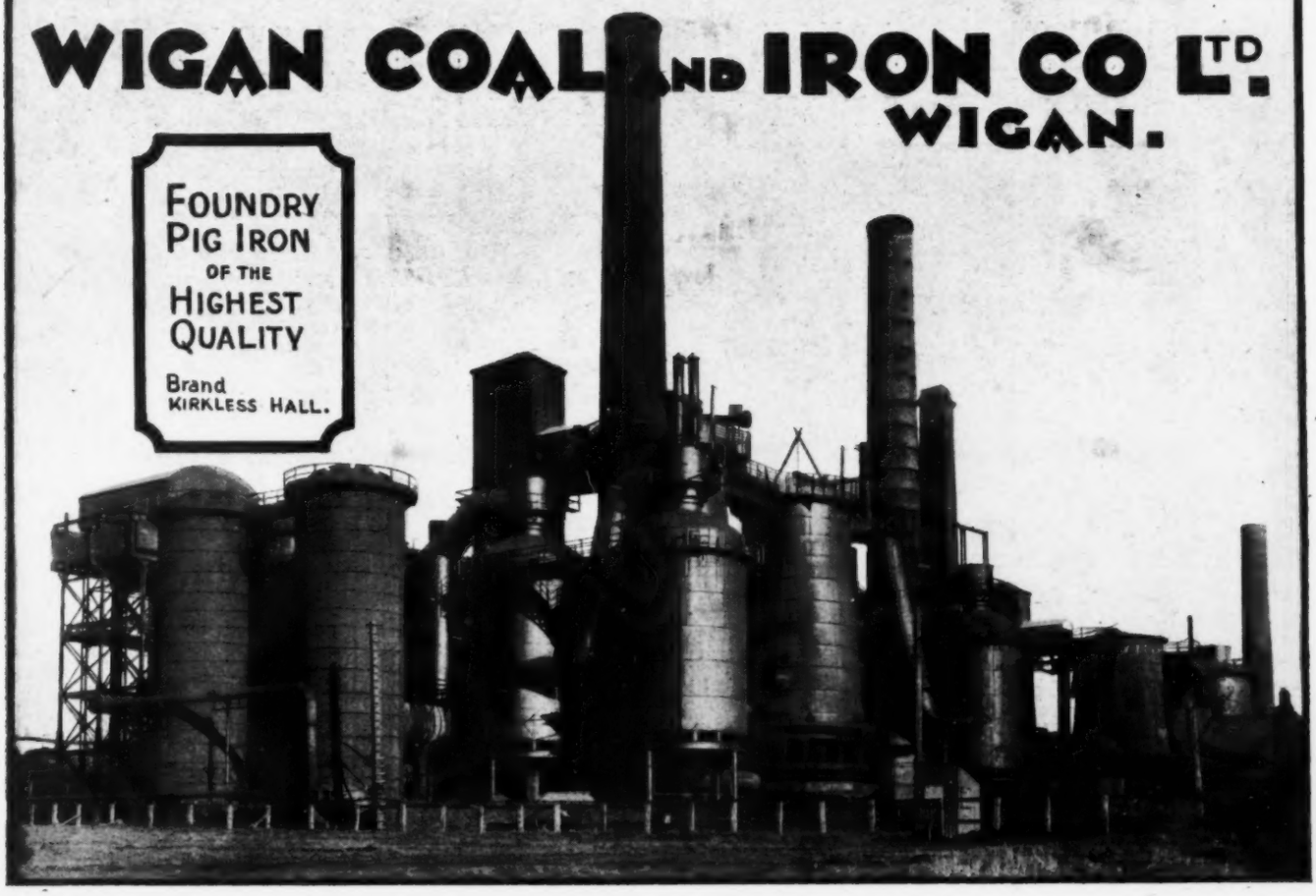

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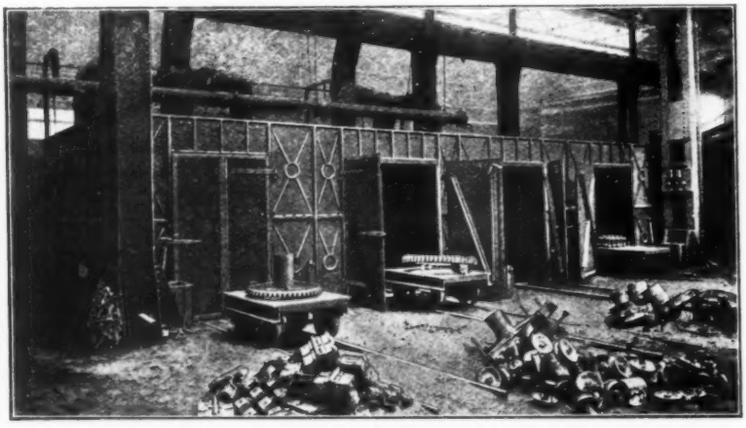

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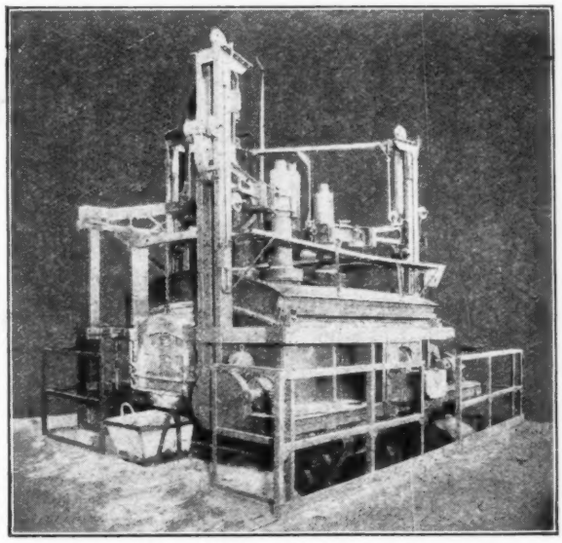

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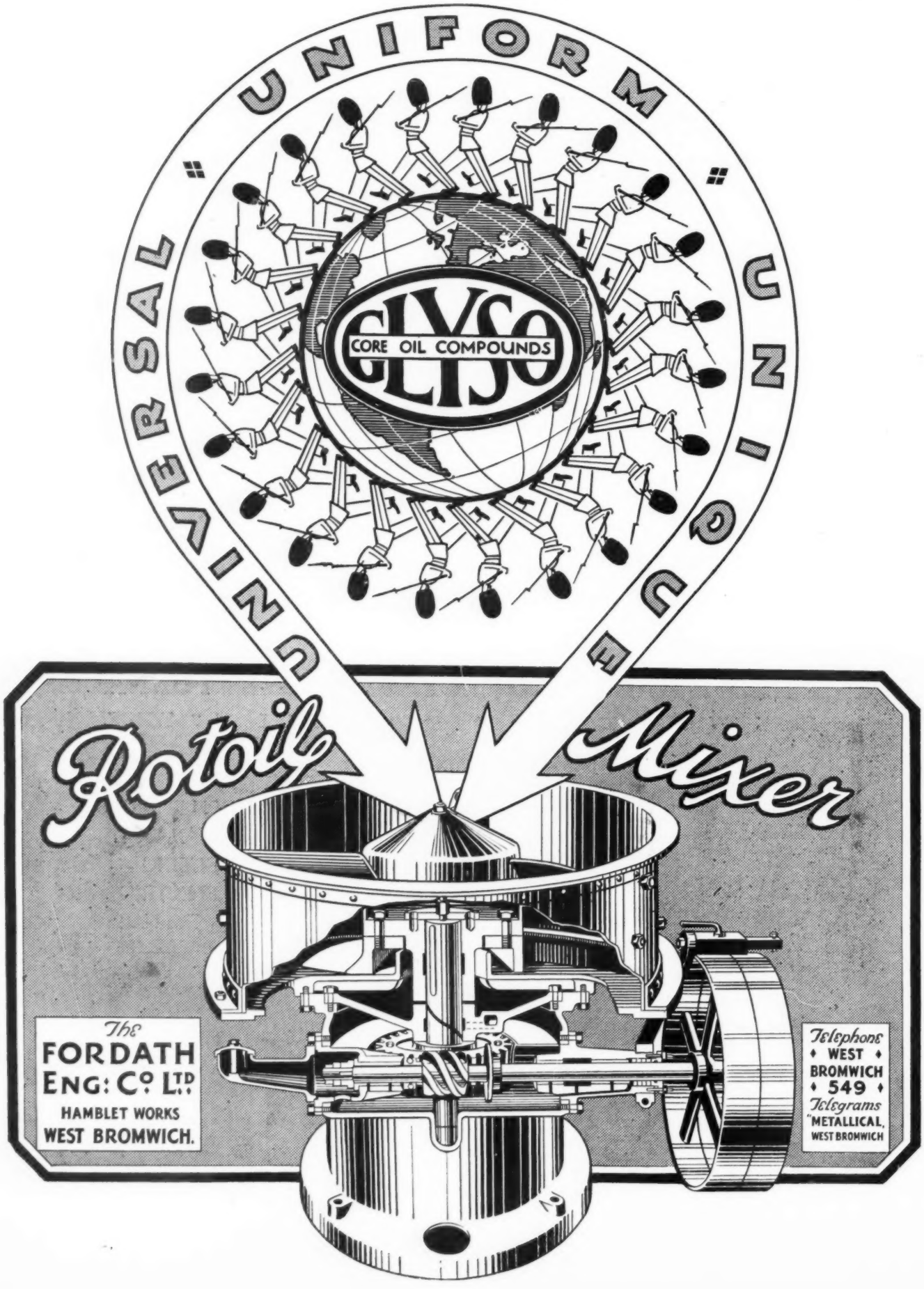
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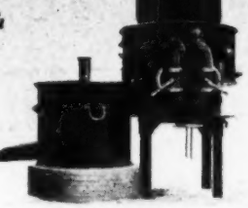

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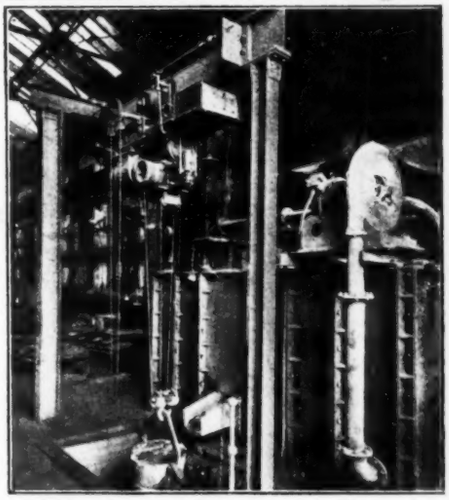

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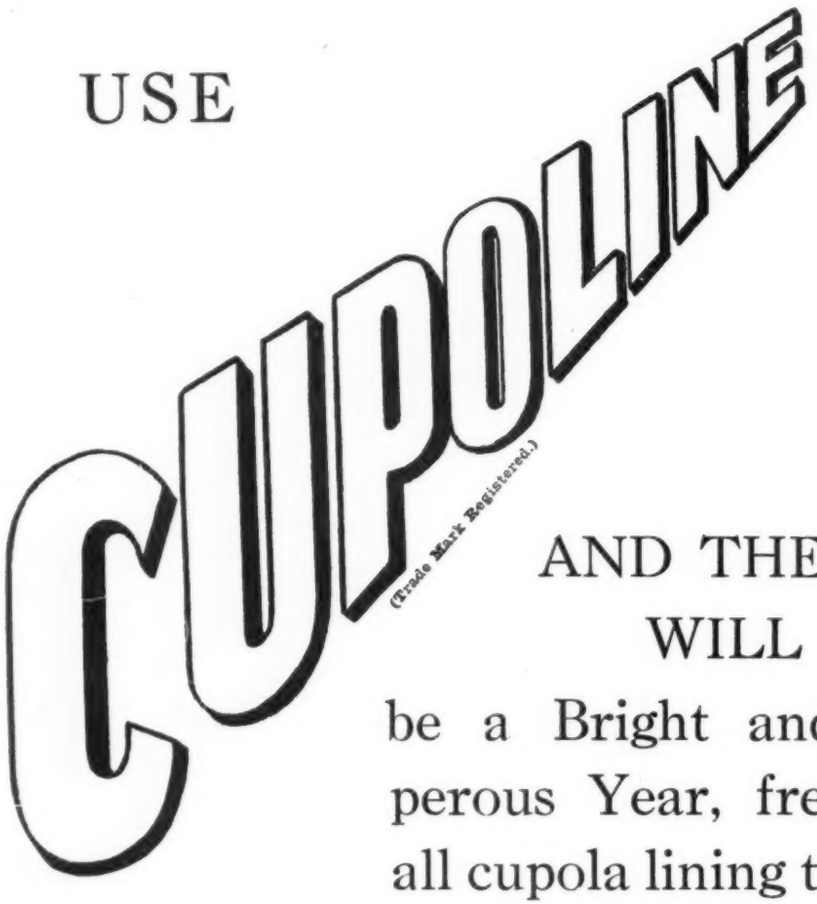


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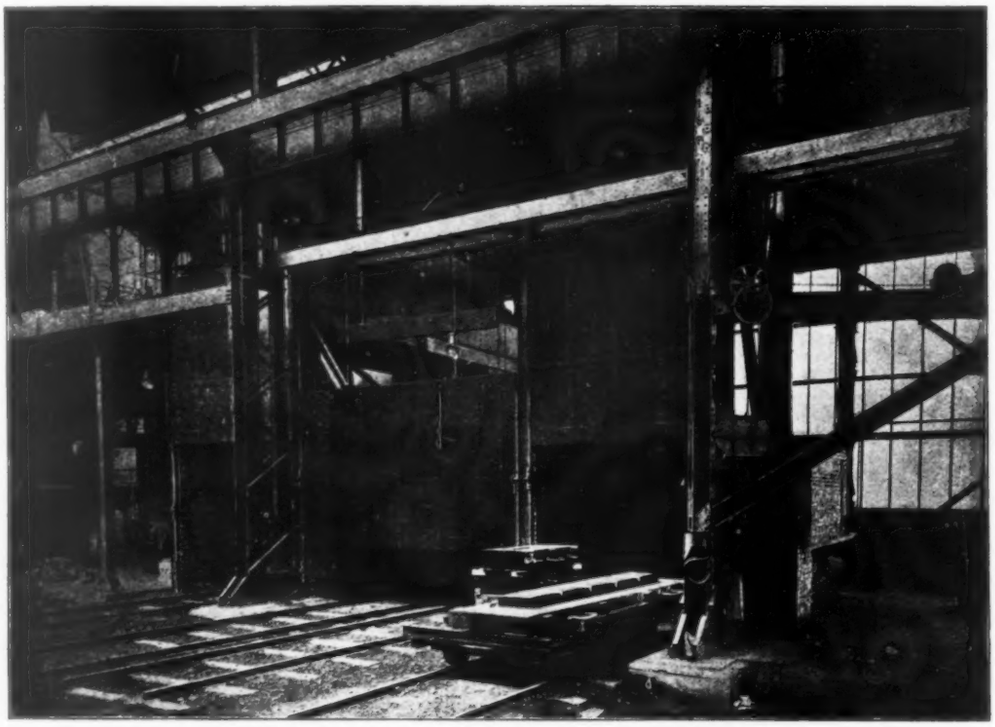

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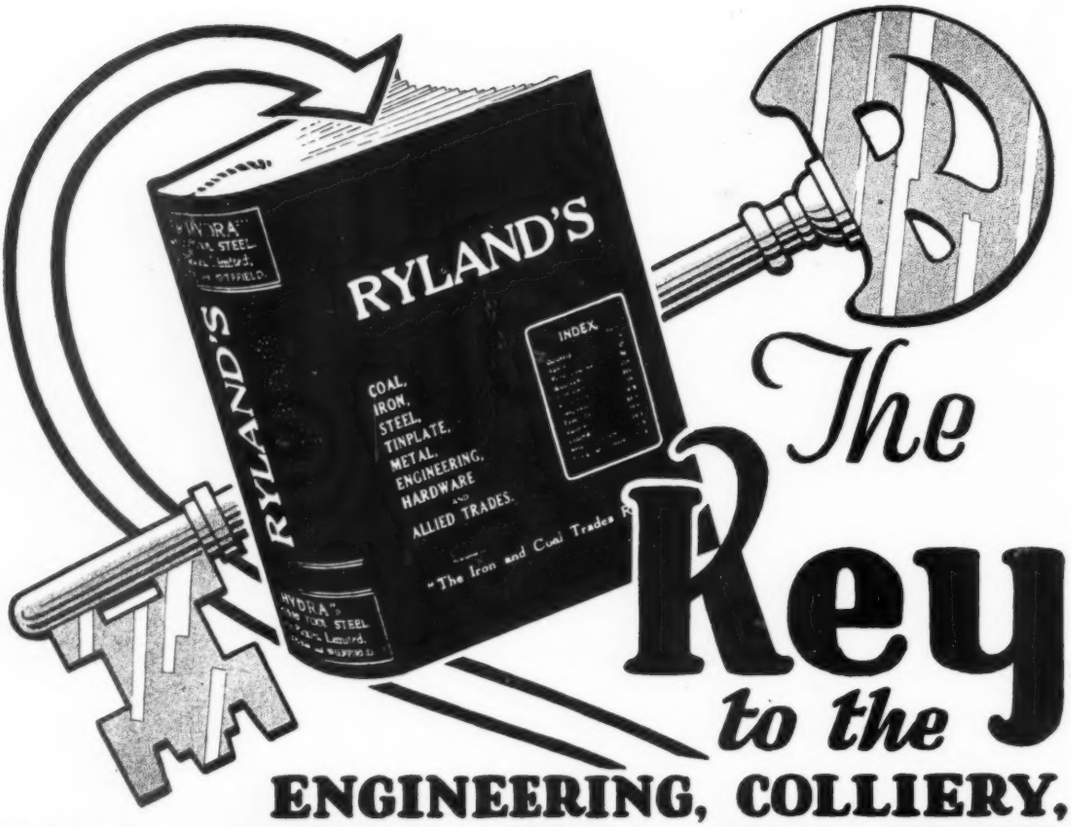


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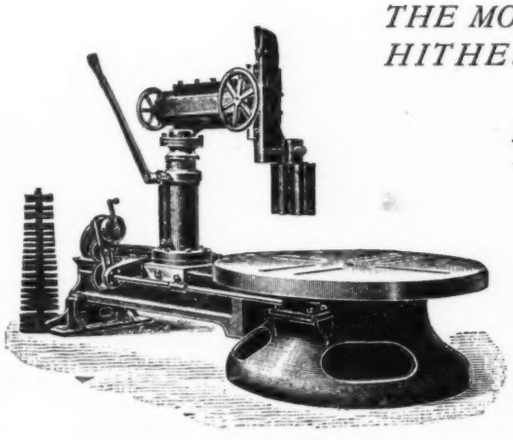

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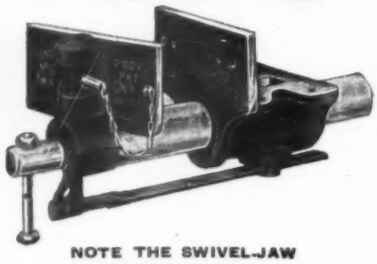

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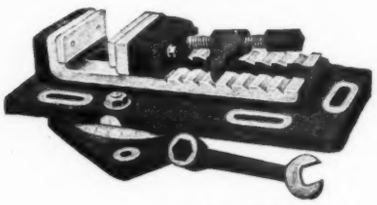

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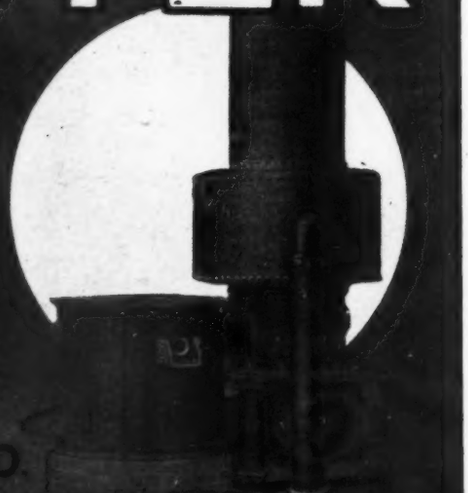

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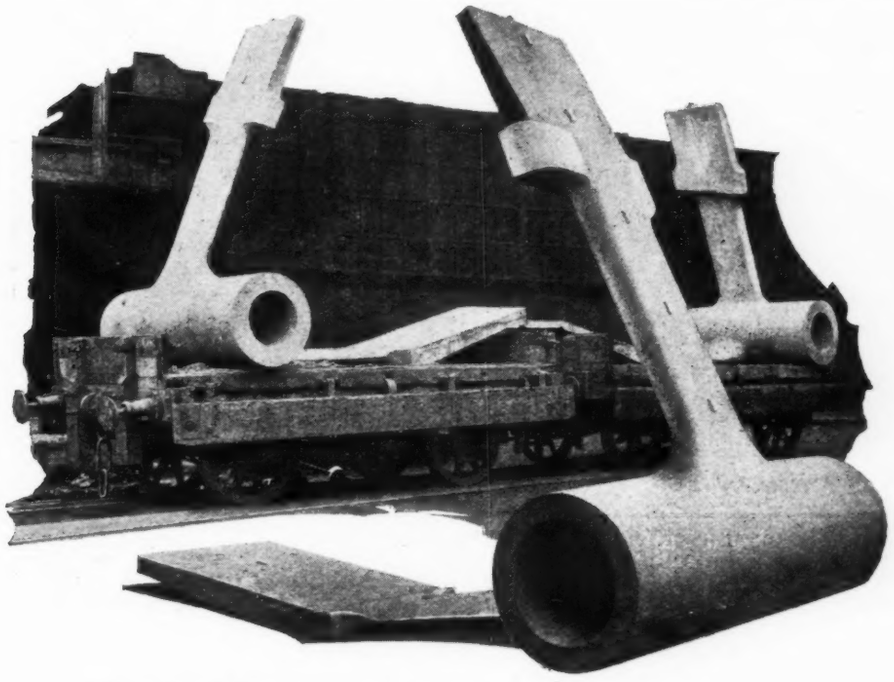

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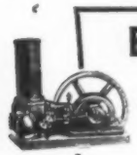

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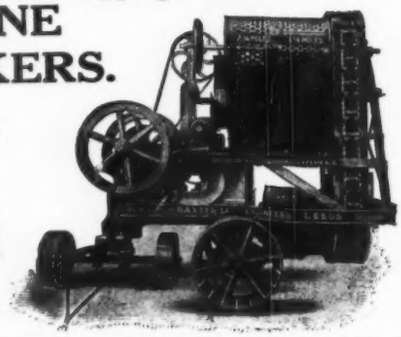

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